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PRESSURE DISTRIBUTIONS OBTAINED ON A 0.04-SCALE AND 0.02-SCALE MODEL OF THE SPACE SHUTTLE ORBITER'S FORWARD FUSELAGE IN THE LANGLEY 20-INCH MACH 6 AIR TUNNEL

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Pressure Distributions Obtained on a 0.04-Scale and 0.02-Scale Model of the Space Shuttle Orbiter's Forward Fuselage in the Langley 20-Inch Mach 6 Tunnel

Pamela F. Bradley; Paul M. Siemers III;
Paul F. Flanagan; and Martin W. Henry

Summary

Results from pressure distribution tests on 0.04-scale and 0.02-scale models of the forward fuselage of the Space Shuttle Orbiter are presented without analysis. The tests were completed in the Langley 20-Inch Mach 6 Tunnel. The 0.04-scale model was tested at angles of attack from 0° to 35° and angles of sideslip from 0° to -4°. The 0.02-scale model was tested at angles of attack from -10° to 45° and angles of sideslip from 0° to -4°.

The tests were conducted in support of the development of the Shuttle Entry Air Data System (SEADS). In addition to modeling the 20 SEADS pressure orifices, the wind-tunnel models were also instrumented with orifices to match Development Flight Instrumentation (DFI) port locations currently existing on the Space Shuttle Orbiter Columbia (OV-102). This DFI simulation has provided a means for comparisons between reentry flight pressure data and wind-tunnel data.

Introduction

The SEADS is an across-the-speed-range, flush-orifice air data system proposed for installation on the Space Shuttle Orbiter (ref. 1). The system consists of 20 pressure orifices, 14 of which are arranged in a cruciform pattern and are installed

N83-31636#

in a baseline geometry nose cap assembly. The other six are located on the forward fuselage. An extensive flow-field model development program has been completed to define the algorithm which will enable researchers to convert the SEADS flight data into research quality air data. This data reduction algorithm is based on a modification to Newtonian flow theory which entails the use of correction factors based on wind-tunnel data obtained across the Mach number range on various models of the orbiter's forward fuselage. The wind-tunnel data presented in this report are an important part of the SEADS data base at Mach 6 (refs. 2 and 3).

Data are presented for two different scale models of the forward fuselage--0.04-scale and 0.02-scale. The smaller model was constructed and tested after data obtained from the 0.04-scale model at high angles of attack appeared to be influenced by interference from the tunnel's walls and boundary layer. The 0.02-scale model data are free of this influence. Both the 0.02-scale and 0.04-scale model data--except for the high angle-of-attack 0.04-scale model data--have been incorporated into the SEADS data base at Mach 6.

The investigations were completed in the 20-Inch Mach 6 Tunnel at the NASA Langley Research Center. The angle of attack was varied from 0° to 35° for the 0.04-scale model and -10° to 45° for the 0.02-scale model. The angle of sideslip was varied from 0° to -4° for both tests. The two models are of the forward fuselage region of the Space Shuttle Orbiter. The models extend back to the canopy region and include scaled forward RCS jet

scallops. The 0.04-scale model has 72 pressure orifices including SEADS, DFI, and SEADS support locations. The smaller 0.02-scale model has 36 pressure orifices including SEADS and DFI locations. The data are presented in plotted and tabular form.

Wind-Tunnel Facility

The tests were conducted in the 20-Inch Mach 6 Tunnel. This tunnel is of the blowdown type. Use of its ejector system allows blowdown runs between 10 and 15 minutes depending upon the stagnation pressure used. It has a 0.508m (20-inch) square test section with a 0.405m (16-inch) test core. Its stagnation temperature at the stagnation pressure tested (1.724 Mpa) was 464 K. The free-stream Reynolds number tested was 15.22×10^6/m.

Models and Instrumentation

The two models were identical in construction except for their size. The 0.04-scale model was instrumented with 72 pressure orifices with the orifice locations matching proposed SEADS, current DFI, and SEADS support locations. The 0.02-scale model was instrumented with 36 pressure orifices. These 36 were selected from the 72 locations on the 0.04-scale model. Those chosen were the SEADS array and the DFI. The reduced number was due to the smaller-sized model with restricted areas for pressure tubing. Only the most critical orifices to SEADS algorithm development and comparison with current orbiter instrumentation were therefore modeled.

Both models were instrumented with two chromel-alumel thermocouples installed near the nose of each model. This instrumentation was necessary to monitor model temperature during

runs in wind tunnels with high stagnation temperatures. The stagnation temperature at the test condition for these tests was lower than the design limit for both models. It was, therefore, not necessary to monitor model temperature during these tests.

Photographs of the models are shown in figures 1 and 2. Figure 3 gives the models' coordinate system. Table I gives the orifice numbers and locations for the 0.04-scale model and table II, for the 0.02-scale model. The SEADS array of orifices is modeled by orifices 201 through 220 on both models. The DFI locations duplicated are listed in table III along with their corresponding model orifices. Both models were sting mounted from the back to the tunnel's injection system.

Test Setup

Data were obtained from the orifices via Baratron absolute pressure transducers for the 0.02-scale model test and via a scani-valve system for the 0.04-scale model test. The 0.04-scale test required three scani-values of 24 ports each to acquire all available data at each data point. Each data point was one angle of atack/sideslip combination and is identified sequentially by the "Ref" number. A typical ejector run of the tunnel was able to collect data for eight to nine data points. The 0.02-scale test required a pinch bar setup on the 20 available Baratron transducers to collect all available data at each point (pinch bar number is referred to as Conf 1 or 2 in table IV). A typical ejector run received data from 10 to 12 points. Both models were also tested in the inverted position (roll = 180°) to determine any flow asymmetry in the tunnel. The various data points tested

are listed in table IV for the 2-percent model and table IX for the 4-percent model.

Presentation of Results

To preserve data accuracy and for the convenience of the reader, the data are presented in tabular form. Tables V through VIII give data for the 2-percent model and tables X through XIII for the 4-percent model. Data are presented in dimensional form (psia). Since the data are being used in both pressure coefficients and nondimensional forms P/Q and P/P_{t_2}, they are presented here in dimensional form along with enough tunnel information to provide the reader any nondimensional form. A limited amount of data is plotted in figures 4 through 7 to show trends. These data are nondimensionalized by P_{t_2} as calculated from tunnel conditions. Some limited comparisons of the present data to flight data have been obtained. Reference 4 presents these comparisons at the time the orbiter passes through Mach 6 during its reentry.

List of Symbols

M_∞	free-stream number
p_i	pressure at orifice "i", psia
p_{t_1}	tunnel stagnation pressure, psia
p_{t_2}	total pressure behind the shock, psia
p_∞	tunnel free-stream static pressure, psia
q_∞	tunnel free-stream dynamic pressure, psia
x,y,z	model coordinates, m
α	angle of attack, deg.
β	angle of sideslip, deg.
λ_i	orifice lateral angle, deg.
ϕ	model roll angle, deg.
ϕ_i	orifice longitudinal angle, deg.

References

1. Pruett, C. D.; Wolf, H.; Siemers, P. M. III; and Heck, M. L.: An Innovative Air Data System for the Space Shuttle Orbiter: Data Analysis Techniques. AIAA Paper No. 81-2455, Nov. 1981.

2. Bradley, P. F.; Siemers, P. M. III; Flanagan, P. F.; and Henry, M. W.: Pressure Distributions on a 0.04-Scale Model of the Space Shuttle Orbiter's Forward Fuselage in the Langley Unitary Plan Wind Tunnel. NASA TM-84628, March 1983.

3. Bradley, P. F.; Siemers, P. M. III; Flanagan, P. F.; and Henry, M. W.: Pressure Distributions Obtained on a 0.04-Scale and 0.02-Scale Model of the Space Shuttle Orbiter's Forward Fuselage in the Langley Continuous Flow Hypersonic Tunnel. NASA TM-84629, March 1983.

4. Bradley, P. F.; Siemers, P. M. III; and Weilmuenster, K. J.: An Evaluation of Space Shuttle Orbiter Forward Fuselage Surface Pressures: Comparisons with Wind-Tunnel and Theoretical Predictions. AIAA Paper No. 83-0119, Jan. 1983.

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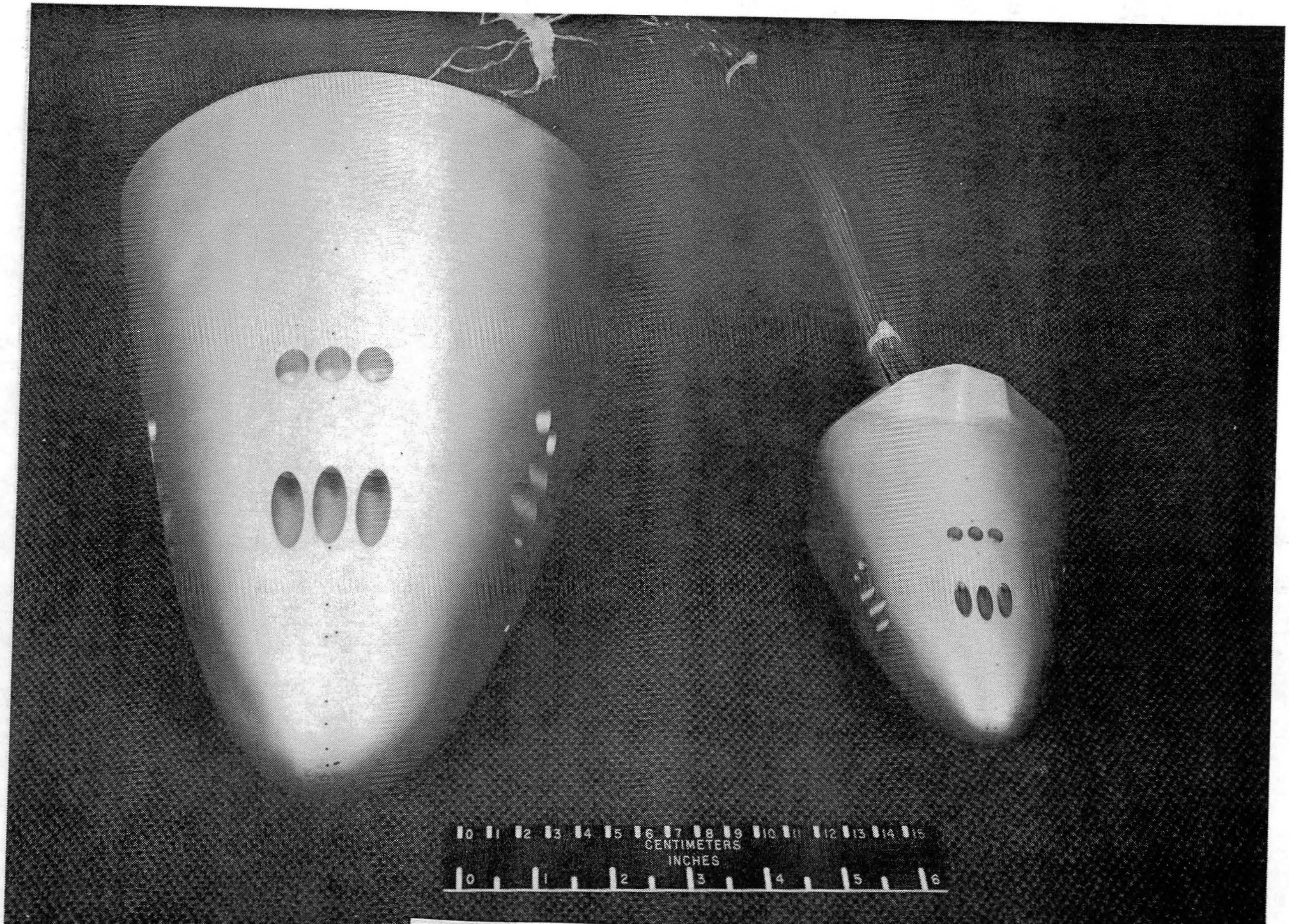

Figure 1. - Photograph of Models.

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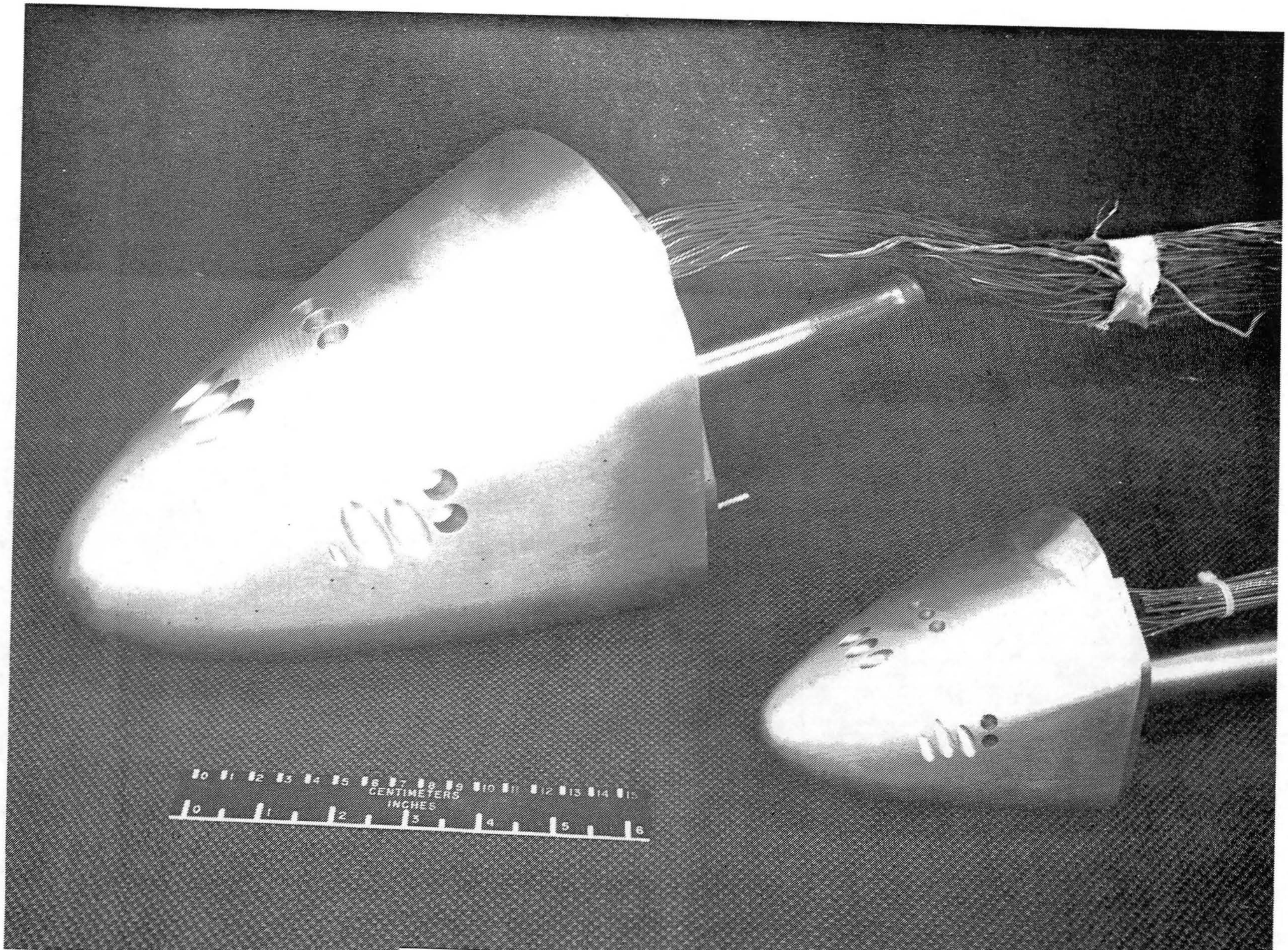

Figure 2. - Photograph of Models.

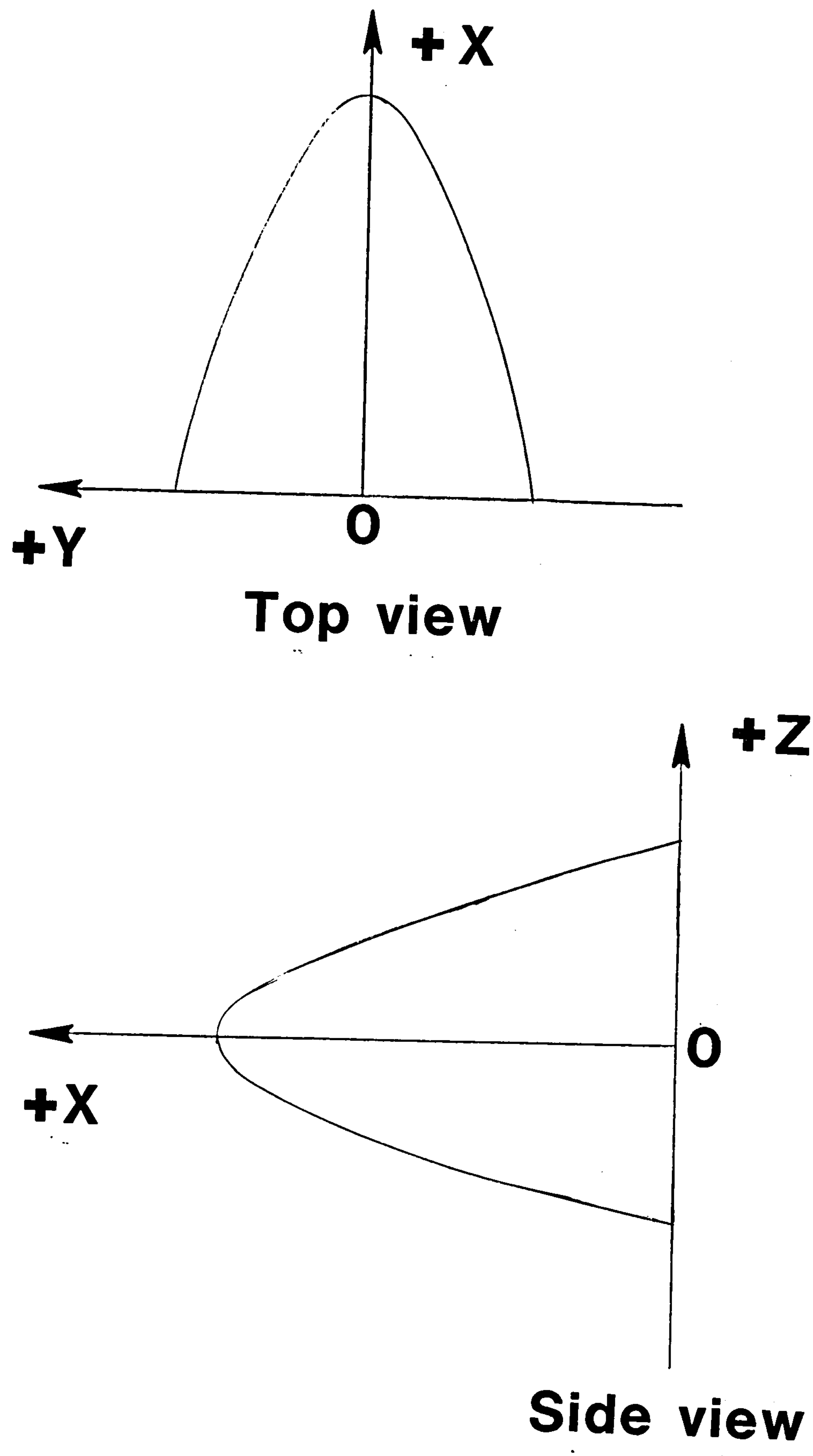

Figure 3. - Models' coordinate system.

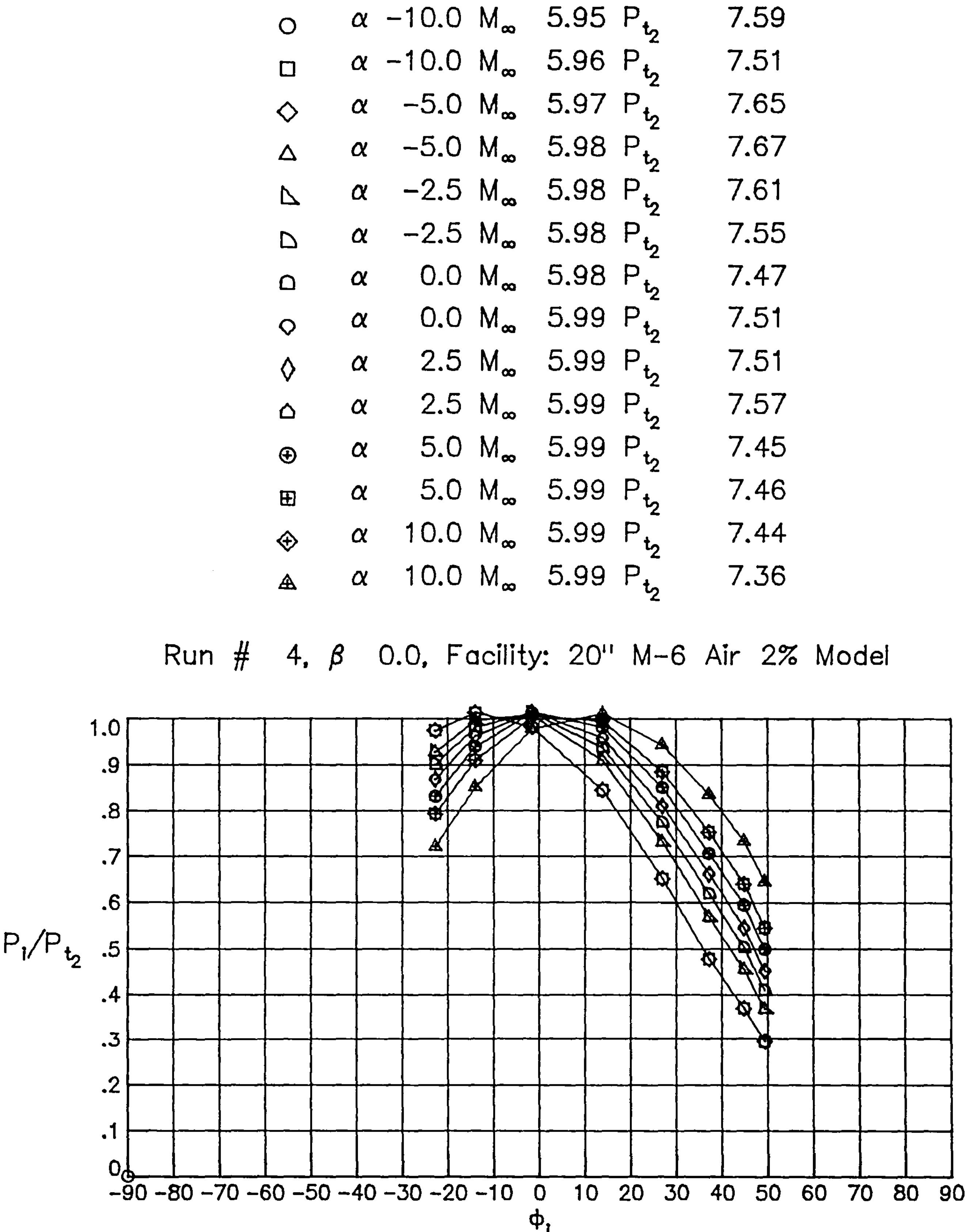

Figure 4. - Sample data, β = 0., longitudinal sweep, 0.02-scale model.

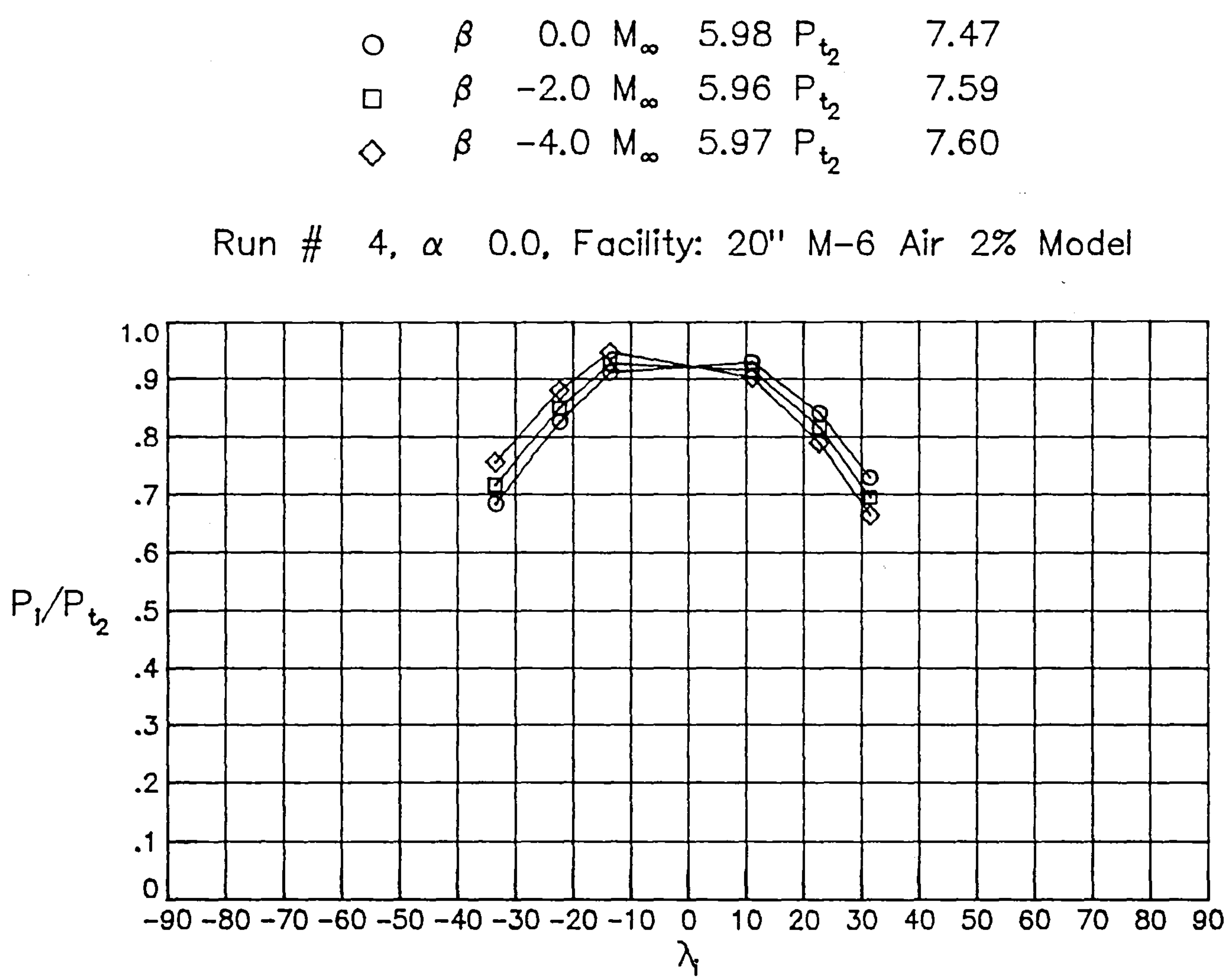

Figure 5. - Sample data, α = 0., lateral sweep, 0.02-scale model.

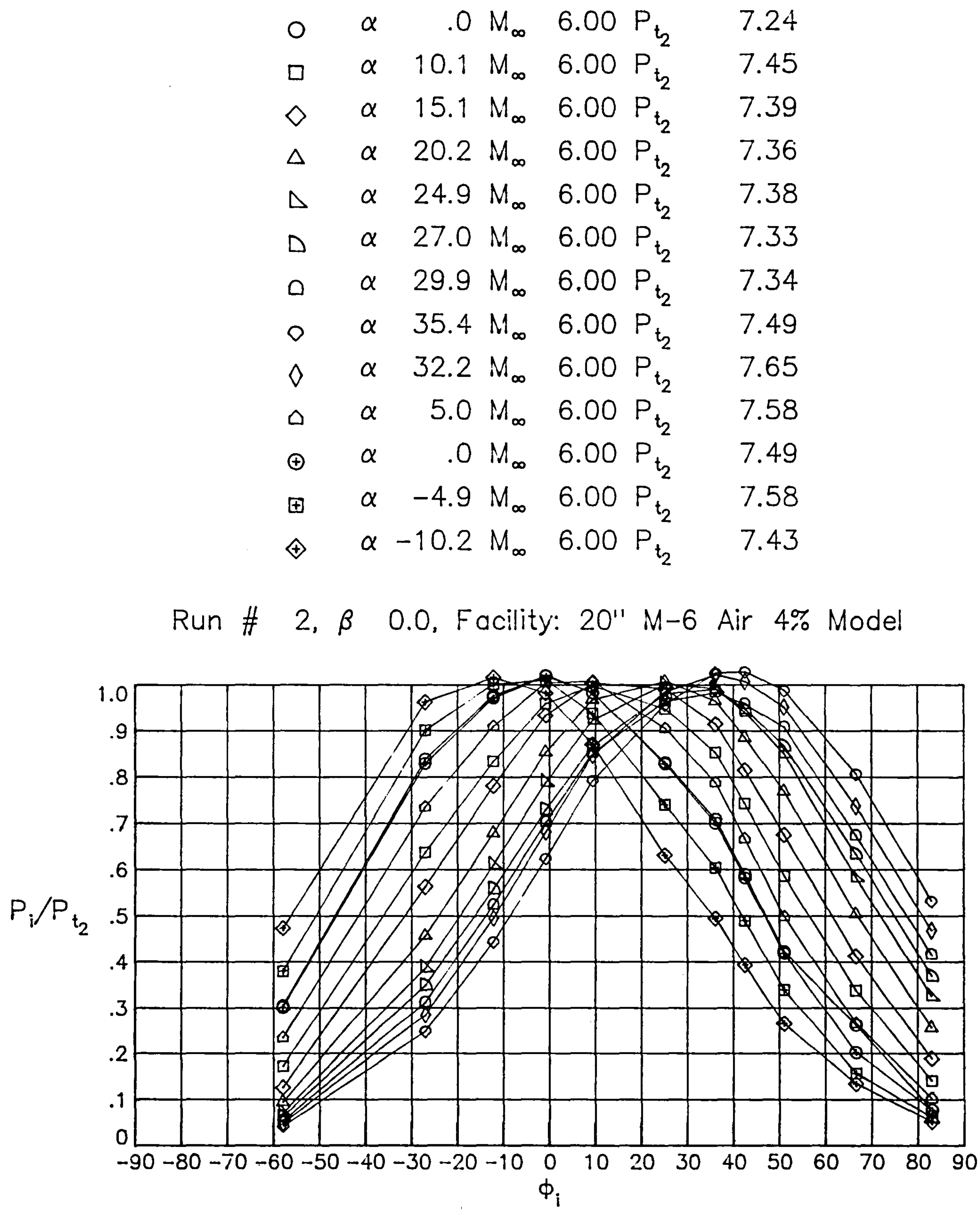

Figure 6. - Sample data, β = 0., longitudinal sweep, 0.04-scale model.

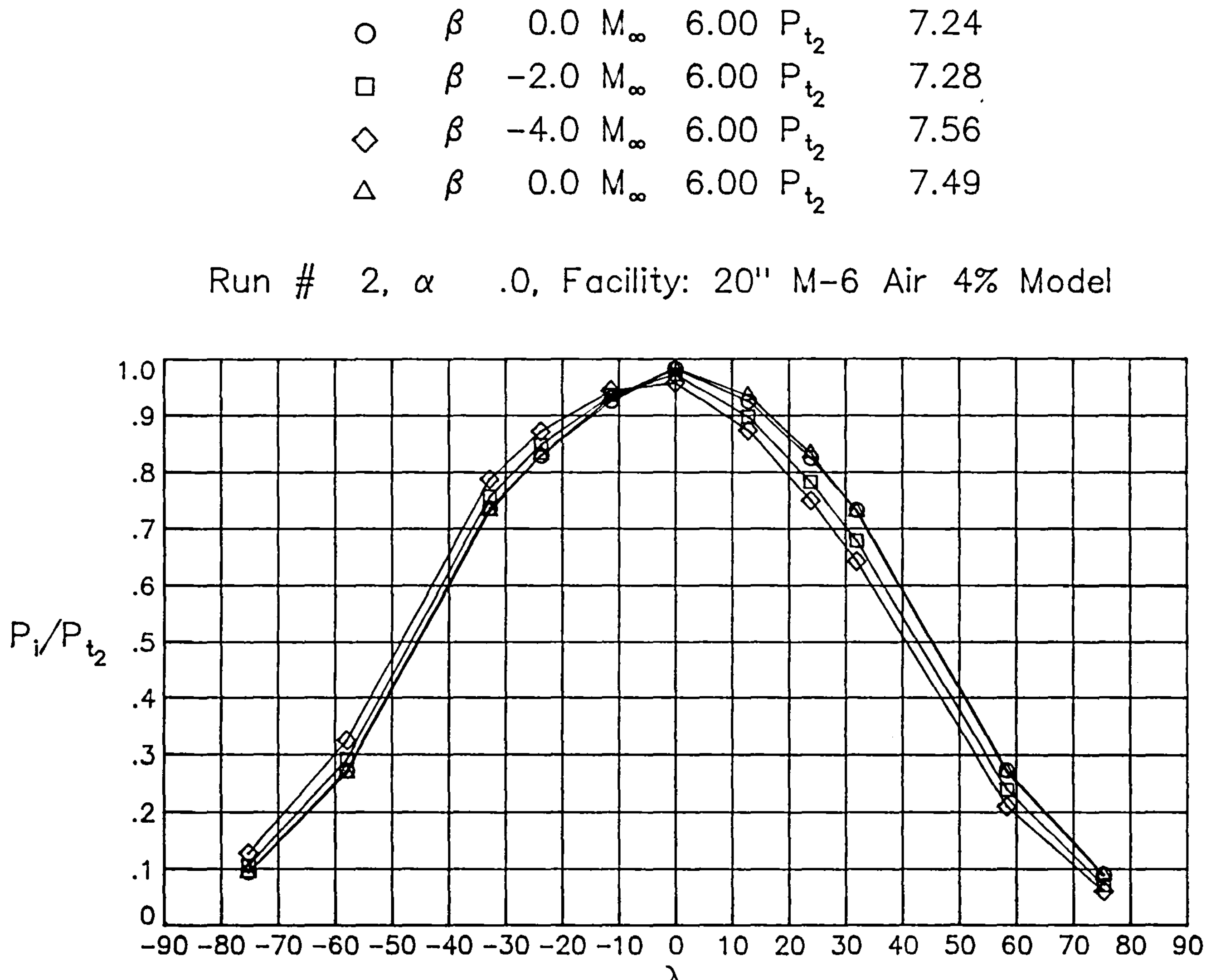

Figure 7. - Sample data, α = 0., lateral sweep, 0.04-scale model.

Table I
0.04-Scale Model Orifice Locations

Orifice Number	X,m	Y,m	Z,m
02	.1880	.0000	.0362
05	.1879	-.0418	.0049
06	.1879	.0418	.0049
09	.1881	.00005	.0419
10	.1676	-.0001	-.0426
13	.1676	-.0508	.0041
14	.1676	.0508	.0041
17	.1717	-.0001	-.0504
19	.1270	-.0646	.0016
20	.1270	.0646	.0016
21	.0863	-.0761	-.0021
22	.0863	.0761	-.0021
23	.0457	-.0856	-.0072
24	.0457	.0856	-.0072
25	.0051	-.0938	-.0193
26	.0051	.0938	-.0193
43	.1721	-.0478	.0183
44	.1721	.0478	.0183
85	.1970	-.0338	.0062
86	.1970	.0338	.0062
87	.1880	-.0315	.0283
88	.1880	.0315	.0283
89	.0701	-.0315	.0553
90	.0701	.0315	.0553
91	.0701	.0000	.0570
92U	.1880	.0000	-.0355
92L	.1880	.0000	.0327
93	.1643	.0000	.0432
128	.0389	-.0019	-.1073
201	.2264	.0000	-.0094
202	.2280	.0000	-.0048
203	.2286	.0000	.0000
204	.2281	.0000	.0047
205	.2265	.0000	.0093
206	.2241	.0000	.0135
207	.2210	.0000	.0173
208	.2174	.0000	.0207
209	.2241	-.0137	.0041
210	.2263	-.0094	.0045
211	.2277	-.0048	.0047
212	.2277	.0048	.0047
213	.2263	.0094	.0045
214	.2241	.0137	.0041
215	.1958	-.0032	-.0380
216	.1959	-.0371	.0114
217	.1959	.0371	.0114
218	.1961	-.0053	.0329
219	.0862	-.0761	.0086
220	.0862	.0761	.0086
225	.1236	.0000	-.0723
226	.2134	.0000	-.0249
227	.2184	.0000	-.0208
228	.2235	.0000	-.0144
229	.2083	.0000	.0269
230	.1199	.0000	.0533
231	.2131	-.0256	.0026
232	.2207	-.0183	.0037
233	.2207	.0183	.0037
234	.2131	.0256	.0026
235	.1010	-.0692	.0294
236	.1004	-.0623	.0389
237	.0951	-.0415	.0503

Table I continued

Orifice Number	X,m	Y,m	Z,m
238	.0964	-.0264	.0529
239	.0953	-.0005	.0544
244	.0699	.0009	-.0945
245	.1009	.0010	-.0818
246	.1405	-.0602	-.0046
247	.0949	-.0737	.0181
248	.0383	-.0873	-.0333
249	.0383	.0873	-.0333
252	.2110	.0000	.0260

Table II
0.02-Scale Model Orifice Locations

Orifice Number	X,m	Y,m	Z,m
201	.1132	.0000	-.0047
202	.1140	.0000	-.0024
203	.1143	.0000	.0000
204	.1140	.0000	.0024
205	.1133	.0000	.0047
206	.1121	.0000	.0068
207	.1105	.0000	.0087
208	.1087	.0000	.0104
209	.1120	-.0069	.0021
210	.1131	-.0047	.0022
211	.1138	-.0024	.0023
212	.1138	.0024	.0023
213	.1131	.0047	.0022
214	.1120	.0069	.0021
215	.0979	-.0016	-.0189
216	.0982	-.0186	.0057
217	.0979	.0186	.0057
218	.0980	-.0027	.0165
219	.0431	-.0381	.0043
220	.0431	.0381	.0043
225	.0618	.0000	-.0361
227	.1092	.0000	-.0104
230	.0599	.0000	.0267
231	.1065	-.0128	.0013
234	.1065	.0128	.0013
235	.0505	-.0346	.0147
236	.0502	-.0311	.0195
237	.0475	-.0208	.0251
238	.0482	-.0132	.0264
239	.0477	-.0025	.0272
244	.0350	.0046	-.0473
245	.0504	.0051	-.0409
246	.0702	-.0301	-.0023
247	.0475	-.0369	.0090
248	.0191	-.0436	-.0167
249	.0191	.0436	-.0167

Table III
Corresponding Orbiter/Model Orifices

Orbiter DFI Designation	Model Orifice
V07P9100	218
V07P9451	218
V07P9453	239
V07P9455	238
V07P9457	237
V07P9459	236
V07P9461	235
V07P9801	215
V07P9805	225
V07P9807	245
V07P9810	244
V07P9871	216
V07P9873	247
V07P9877	246
V07P9887	248
V07P9888	249

Table IV: Data Summary - 20-Inch Mach 6 Air Tunnel - 2% Model

Ref	Run	Conf	M_∞	α deg	β deg	ϕ deg	P_{t_1} psia	q_∞ psia	P_∞ psia	P_{t_2} psia
1	2	2	5.95	10.0	0.0	180	247.09	4.073	.164	7.568
2	2	1	5.97	10.0	0.0	180	252.66	4.126	.166	7.666
3	2	2	5.97	5.0	0.0	180	248.34	4.045	.162	7.516
4	2	1	5.98	5.0	0.0	180	254.24	4.116	.165	7.647
5	2	2	5.98	2.5	0.0	180	259.80	4.203	.168	7.809
6	2	1	5.98	2.5	0.0	180	250.50	4.040	.161	7.506
7	2	2	5.99	0.0	0.0	180	247.34	3.986	.159	7.404
8	2	1	5.99	0.0	0.0	180	249.50	4.017	.160	7.463
9	2	2	5.99	-2.5	0.0	180	244.11	3.930	.157	7.302
10	2	1	5.99	-2.5	0.0	180	247.68	3.975	.158	7.385
11	2	2	5.99	-5.0	0.0	180	250.66	4.019	.160	7.466
12	2	1	6.00	-5.0	0.0	180	249.09	3.989	.159	7.411
13	2	2	6.00	-10.0	0.0	180	250.66	4.010	.159	7.449
14	2	1	6.00	-10.0	0.0	180	251.00	4.014	.159	7.457
15	4	2	5.95	-10.0	0.0	0	247.84	4.085	.165	7.589
16	4	1	5.96	-10.0	0.0	0	247.01	4.040	.162	7.507
17	4	2	5.97	-5.0	0.0	0	252.66	4.119	.165	7.652
18	4	1	5.98	-5.0	0.0	0	254.48	4.126	.165	7.666
19	4	2	5.98	-2.5	0.0	0	252.91	4.098	.164	7.613
20	4	1	5.98	-2.5	0.0	0	251.25	4.063	.162	7.549
21	4	2	5.98	0.0	0.0	0	248.84	4.022	.161	7.473
22	4	1	5.99	0.0	0.0	0	250.91	4.042	.161	7.509
23	4	2	5.99	2.5	0.0	0	250.91	4.040	.161	7.506
24	4	1	5.99	2.5	0.0	0	253.40	4.073	.162	7.567
25	4	2	5.99	5.0	0.0	0	249.59	4.012	.160	7.454
26	4	1	5.99	5.0	0.0	0	250.08	4.013	.160	7.455
27	4	2	5.99	10.0	0.0	0	249.75	4.006	.159	7.442
28	4	1	5.99	10.0	0.0	0	247.18	3.961	.158	7.358
29	4	2	6.00	15.0	0.0	0	252.16	4.037	.160	7.499
30	4	1	6.00	15.0	0.0	0	247.68	3.960	.157	7.357
31	4	2	6.00	20.0	0.0	0	253.99	4.061	.161	7.544
32	4	1	6.00	20.0	0.0	0	250.08	3.993	.158	7.417
33	4	2	6.00	25.0	0.0	0	247.76	3.959	.157	7.355
34	4	1	6.00	25.0	0.0	0	247.76	3.953	.157	7.344
35	4	2	6.00	30.0	0.0	0	249.92	3.984	.158	7.402
36	4	1	6.00	30.0	0.0	0	247.26	3.941	.156	7.321
37	4	2	6.00	35.0	0.0	0	244.85	3.909	.155	7.262
38	4	1	6.00	35.0	0.0	0	245.93	3.917	.155	7.277
39	5	2	5.95	-10.0	-2.0	0	254.07	4.200	.170	7.804
40	5	1	5.96	-10.0	-2.0	0	250.42	4.113	.166	7.641
41	5	2	5.96	0.0	-2.0	0	249.25	4.085	.164	7.590
42	5	1	5.97	0.0	-2.0	0	249.67	4.077	.164	7.575
43	5	2	5.97	10.0	-2.0	0	251.83	4.103	.164	7.623
44	5	1	5.97	10.0	-2.0	0	251.50	4.086	.164	7.592
47	5	2	5.98	20.0	-2.0	0	246.26	3.994	.160	7.419
48	5	1	5.98	20.0	-2.0	0	252.41	4.082	.163	7.583
49	5	2	5.98	25.0	-2.0	0	251.58	4.065	.162	7.551
50	5	1	5.98	25.0	-2.0	0	252.99	4.081	.163	7.581
51	5	2	5.99	30.0	-2.0	0	249.17	4.019	.160	7.466
52	5	1	5.98	30.0	-2.0	0	246.43	3.977	.159	7.388
53	5	2	5.99	35.0	-2.0	0	246.76	3.980	.159	7.393
54	5	1	5.99	35.0	-2.0	0	247.09	3.979	.159	7.392
55	5	2	5.99	40.0	-2.0	0	250.33	4.030	.161	7.487
56	5	1	5.99	40.0	-2.0	0	250.25	4.024	.160	7.476
57	5	2	5.99	45.0	-2.0	0	250.42	4.028	.160	7.482
58	5	1	5.99	45.0	-2.0	0	250.58	4.025	.160	7.477
59	5	2	5.99	45.0	0.0	0	249.83	4.015	.160	7.459
60	5	1	5.99	45.0	0.0	0	249.83	4.009	.160	7.447
61	5	2	5.99	40.0	0.0	0	249.75	4.011	.160	7.452
62	5	1	5.99	40.0	0.0	0	249.83	4.010	.160	7.449
63	5	2	5.99	35.0	0.0	0	249.75	4.009	.160	7.448
64	5	1	5.99	35.0	0.0	0	249.67	4.004	.159	7.439

Table IV(continued)

Ref	Run	Conf	M_∞	α	β	ϕ	P_{t_1}	q_∞	P_∞	P_{t_2}
				deg	deg	deg	psia	psia	psia	psia
65	7	2	5.96	-10.0	-4.0	0	248.34	4.074	.164	7.569
66	7	1	5.97	-10.0	-4.0	0	246.68	4.029	.162	7.486
67	7	2	5.97	0.0	-4.0	0	251.00	4.089	.164	7.597
68	7	1	5.97	0.0	-4.0	0	253.65	4.120	.165	7.655
69	7	2	5.98	10.0	-4.0	0	253.74	4.118	.165	7.650
70	7	1	5.98	10.0	-4.0	0	252.24	4.082	.163	7.584
71	7	2	5.98	15.0	-4.0	0	250.17	4.046	.162	7.518
72	7	1	5.98	15.0	-4.0	0	248.09	4.006	.160	7.442
73	7	2	5.98	20.0	-4.0	0	248.26	4.008	.160	7.446
74	7	1	5.99	20.0	-4.0	0	249.17	4.018	.160	7.465
75	7	2	5.99	25.0	-4.0	0	249.59	4.022	.160	7.472
76	7	1	5.99	25.0	-4.0	0	249.34	4.014	.160	7.457
77	7	2	5.99	30.0	-4.0	0	245.52	3.958	.158	7.352
78	7	1	5.99	30.0	-4.0	0	247.92	3.984	.159	7.402
79	7	2	5.99	35.0	-4.0	0	250.50	4.026	.160	7.480
80	7	1	5.99	35.0	-4.0	0	251.08	4.033	.161	7.493
81	7	2	5.99	40.0	-4.0	0	250.42	4.022	.160	7.472
82	7	1	5.99	40.0	-4.0	0	250.17	4.012	.160	7.453
83	7	2	5.99	45.0	-4.0	0	250.17	4.013	.160	7.456
84	7	1	5.99	45.0	-4.0	0	250.17	4.008	.159	7.446

Table V: 20-Inch Mach 6 Air Tunnel - 2% Model
Nominal Conditions: $\beta =$ 0.0°, $M_\infty =$ 6.0, Inverted, Pressures in psia

Orifice ID	Nominal α													
	-10.0°		-5.0°		-2.5°		0.0°		2.5°		5.0°		10.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
201	14	7.212	12	6.859	10	6.645	8	6.471	6	6.278	4	6.106	2	5.539
202	14	7.513	12	7.369	10	7.256	8	7.180	6	7.063	4	6.979	2	6.520
203	14	7.324	12	7.447	10	7.474	8	7.555	6	7.588	4	7.682	2	7.486
204	14	6.313	12	6.732	10	6.909	8	7.162	6	7.353	4	7.595	2	7.730
205	14	4.906	12	5.418	10	5.686	8	6.043	6	6.366	4	6.733	2	7.211
206	14	3.678	12	4.264	10	4.551	8	4.940	6	5.292	4	5.709	2	6.375
207	14	2.940	12	3.451	10	3.712	8	4.078	6	4.469	4	4.859	2	5.605
208	14	2.151	12	2.720	10	3.005	8	3.376	6	3.768	4	4.195	2	4.927
209	13	4.667	11	4.917	9	4.938	7	5.106	5	5.409	3	5.343	1	5.371
210	13	5.531	11	5.879	9	5.918	7	6.143	5	6.544	3	6.426	1	6.522
211	13	6.032	11	6.461	9	6.520	7	6.791	5	7.251	3	7.137	1	7.270
212	13	6.095	11	6.536	9	6.608	7	6.895	5	7.367	3	7.254	1	7.406
213	13	5.638	11	5.981	9	6.016	7	6.244	5	6.645	3	6.526	1	6.622
214	13	5.006	11	5.220	9	5.240	7	5.416	5	5.733	3	5.625	1	5.664
215	14	3.446	12	2.791	10	2.500	8	2.231	6	1.988	4	1.796	2	1.296
216	14	1.661	12	1.872	10	1.941	8	2.052	6	2.160	4	2.319	2	2.403
217	13	1.909	11	2.098	9	2.169	7	2.269	5	2.264	3	2.575	1	2.347
218	13	1.056	11	1.332	9	1.490	7	1.686	5	1.814	3	2.213	1	2.517
219	14	.734	12	.729	10	.737	8	.759	6	.786	4	.798	2	.815
220	13	.710	11	.715	9	.732	7	.756	5	.782	3	.800	1	.752
225	13	2.408	11	1.879	9	1.637	7	1.394	5	1.193	3	1.131	1	.668
227	14	5.255	12	4.548	10	4.211	8	3.906	6	3.610	4	3.397	2	2.757
230	13	.336	11	.387	9	.443	7	.512	5	.637	3	.757	1	.941
231	14	3.217	12	3.283	10	3.293	8	3.337	6	3.385	4	3.424	2	3.415
234	13	3.181	11	3.247	9	3.235	7	3.301	5	3.448	3	3.388	1	3.347
235	13	.992	11	1.142	9	1.193	7	1.234	5	.996	3	1.446	1	.900
236	14	.371	12	.455	10	.508	8	.607	6	.693	4	.811	2	1.013
237	13	.667	11	.767	9	.832	7	.898	5	.765	3	1.136	1	.865
238	13	.350	11	.403	9	.459	7	.545	5	.591	3	.744	1	.834
239	14	.309	12	.356	10	.396	8	.455	6	.523	4	.643	2	.876
244	14	2.483	12	1.873	10	1.609	8	1.356	6	1.162	4	.986	2	.667
245	13	2.364	11	1.786	9	1.515	7	1.290	5	1.142	3	.905	1	.635
246	14	1.026	12	.987	10	.971	8	.973	6	.984	4	1.000	2	.986
247	13	.738	11	.783	9	.803	7	.832	5	.847	3	.898	1	.840
248	14	.698	12	.663	10	.649	8	.642	6	.648	4	.632	2	.607
249	13	.681	11	.655	9	.645	7	.645	5	.657	3	.640	1	.584

Table VI: 20-Inch Mach 6 Air Tunnel - 2% Model

Nominal Conditions: $\beta = 0.0^\circ$, $M_\infty = 6.0$, Upright, Pressures in psia

Orifice	Nominal α													
	-10.0°		-5.0°		-2.5°		0.0°		2.5°		5.0°		10.0°	
ID	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
201	16	7.321	18	7.113	20	6.801	22	6.524	24	6.294	26	5.912	28	5.309
202	16	7.606	18	7.642	20	7.419	22	7.236	24	7.112	26	6.786	28	6.265
203	16	7.378	18	7.729	20	7.645	22	7.612	24	7.669	26	7.486	28	7.202
204	16	6.341	18	6.972	20	7.072	22	7.203	24	7.433	26	7.422	28	7.437
205	16	4.890	18	5.606	20	5.840	22	6.082	24	6.438	26	6.598	28	6.940
206	16	3.587	18	4.364	20	4.668	22	4.969	24	5.345	26	5.608	28	6.145
207	16	2.769	18	3.485	20	3.797	22	4.099	24	4.499	26	4.770	28	5.393
208	16	2.205	18	2.813	20	3.086	22	3.388	24	3.777	26	4.067	28	4.743
209	15	4.736	17	5.008	19	5.125	21	5.113	23	5.219	25	5.223	27	5.258
210	15	5.616	17	6.013	19	6.168	21	6.178	23	6.327	25	6.344	27	6.408
211	15	6.119	17	6.600	19	6.791	21	6.816	23	7.013	25	7.046	27	7.145
212	15	6.218	17	6.706	19	6.914	21	6.944	23	7.139	25	7.185	27	7.273
213	15	5.765	17	6.134	19	6.291	21	6.285	23	6.430	25	6.445	27	6.475
214	15	5.104	17	5.363	19	5.477	21	5.450	23	5.546	25	5.538	27	5.524
215	16	3.519	18	2.898	20	2.539	22	2.227	24	1.955	26	1.665	28	1.216
216	16	1.805	18	1.949	20	1.984	22	2.036	24	2.114	26	2.115	28	2.250
217	15	1.848	17	2.031	19	2.145	21	2.173	23	2.285	25	2.269	27	2.361
218	15	.890	17	1.187	19	1.402	21	1.557	23	1.797	25	1.980	27	2.491
219	16	.724	18	.718	20	.725	22	.729	24	.743	26	.746	28	.763
220	15	.706	17	.702	19	.713	21	.713	23	.725	25	.734	27	.745
225	15	2.491	17	1.924	19	1.696	21	1.457	23	1.247	25	1.044	27	.863
227	16	5.399	18	4.768	20	4.304	22	3.894	24	3.537	26	3.121	28	2.570
230	15	.328	17	.312	19	.352	21	.408	23	.483	25	.634	27	.859
231	16	3.210	18	3.355	20	3.344	22	3.335	24	3.367	26	3.318	28	3.258
234	15	3.265	17	3.322	19	3.355	21	3.302	23	3.330	25	3.298	27	3.250
235	15	.525	17	.971	19	1.088	21	1.101	23	1.187	25	1.105	27	1.189
236	16	.344	18	.409	20	.470	22	.555	24	.641	26	.725	28	.943
237	15	.311	17	.612	19	.713	21	.750	23	.842	25	.851	27	1.031
238	15	.303	17	.306	19	.355	21	.404	23	.472	25	.579	27	.782
239	16	.285	18	.303	20	.337	22	.385	24	.456	26	.590	28	.810
244	16	2.536	18	1.923	20	1.630	22	1.361	24	1.130	26	.929	28	.672
245	15	2.459	17	1.859	19	1.615	21	1.368	23	1.159	25	.962	27	.756
246	16	1.065	18	.997	20	.971	22	.953	24	.949	26	.931	28	.927
247	15	.672	17	.753	19	.783	21	.789	23	.810	25	.817	27	.848
248	16	.686	18	.655	20	.640	22	.619	24	.611	26	.595	28	.572
249	15	.679	17	.657	19	.645	21	.622	23	.613	25	.602	27	.584

Table VI(continued)

Nominal Conditions: $\beta = 0.0^{\circ}$, $M_{\infty} = 6.0$, Upright, Pressures in psia

Orifice ID	Nominal α 15.0° Ref	15.0° Pi	20.0° Ref	20.0° Pi	25.0° Ref	25.0° Pi	30.0° Ref	30.0° Pi	35.0° Ref	35.0° Pi	40.0° Ref	40.0° Pi	45.0° Ref	45.0° Pi
201	30	4.704	32	4.019	34	3.318	36	2.738	38	2.205	62	1.824	60	1.510
202	30	5.729	32	5.117	34	4.371	36	3.722	38	3.090	62	2.677	60	2.208
203	30	6.904	32	6.465	34	5.812	36	5.292	38	4.617	62	4.035	60	3.353
204	30	7.463	32	7.353	34	6.970	36	6.604	38	6.062	62	5.596	60	4.950
205	30	7.273	32	7.470	34	7.382	36	7.304	38	7.022	62	6.780	60	6.277
206	30	6.679	32	7.117	34	7.268	36	7.388	38	7.350	62	7.328	60	7.061
207	30	6.010	32	6.567	34	6.880	36	7.176	38	7.331	62	7.486	60	7.424
208	30	5.365	32	5.983	34	6.409	36	6.826	38	7.126	62	7.473	60	7.544
209	29	5.254	31	5.113	33	4.788	35	4.514	37	4.024	61	3.703	59	3.290
210	29	6.420	31	6.261	33	5.872	35	5.552	37	5.005	61	4.668	59	4.148
211	29	7.203	31	7.060	33	6.643	35	6.323	37	5.688	61	5.305	59	4.716
212	29	7.351	31	7.224	33	6.784	35	6.470	37	5.816	61	5.418	59	4.832
213	29	6.493	31	6.328	33	5.889	35	5.571	37	5.024	61	4.638	59	4.073
214	29	5.505	31	5.328	33	4.957	35	4.649	37	4.161	61	3.900	59	3.434
215	30	.901	32	.695	34	.547	36	.431	38	.372	62	.280	60	.271
216	30	2.301	32	2.288	34	2.239	36	2.208	38	2.144	62	2.283	60	2.222
217	29	2.359	31	2.481	33	2.398	35	2.242	37	2.080	61	1.988	59	1.884
218	29	3.095	31	3.757	33	4.388	35	5.069	37	5.552	61	6.281	59	6.768
219	30	.792	32	.802	34	.787	36	.755	38	.715	62	.704	60	.703
220	29	.781	31	.793	33	.789	35	.762	37	.722	61	.704	59	.704
225	29	.624	31	.607	33	.512	35	.395	37	.346	61	.259	59	.261
227	30	2.044	32	1.610	34	1.283	36	1.088	38	.957	62	.959	60	.925
230	29	1.275	31	1.654	33	2.283	35	2.955	37	3.518	61	4.289	59	4.945
231	30	3.180	32	3.042	34	2.806	36	2.612	38	2.385	62	2.194	60	1.957
234	29	3.210	31	3.077	33	2.863	35	2.674	37	2.386	61	2.191	59	1.968
235	29	1.099	31	1.285	33	1.284	35	1.328	37	1.402	61	1.481	59	1.598
236	30	1.202	32	1.558	34	1.843	36	2.165	38	2.461	62	2.871	60	3.113
237	29	1.244	31	1.706	33	2.131	35	2.697	37	3.198	61	3.881	59	4.478
238	29	1.157	31	1.525	33	2.102	35	2.726	37	3.261	61	3.993	59	4.638
239	30	1.149	32	1.560	34	2.123	36	2.695	38	3.311	62	4.055	60	4.720
244	30	.527	32	.444	34	.379	36	.343	38	.326	62	.256	60	.251
245	29	.552	31	.475	33	.371	35	.355	37	.331	61	.258	59	.258
246	30	.926	32	.914	34	.893	36	.881	38	.857	62	.842	60	.830
247	29	.871	31	.878	33	.856	35	.833	37	.824	61	.837	59	.874
248	30	.566	32	.558	34	.563	36	.586	38	.585	62	.578	60	.578
249	29	.577	31	.570	33	.569	35	.592	37	.592	61	.589	59	.595

Table VII: 20-Inch Mach 6 Air Tunnel - 2% Model
Nominal Conditions: β = -2.0°, M_∞ = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α									
	-10.0°		0.0°		10.0°		20.0°		25.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
201	40	7.483	42	6.582	44	5.492	48	4.109	50	3.389
202	40	7.751	42	7.299	44	6.467	48	5.211	50	4.549
203	40	7.539	42	7.694	44	7.455	48	6.640	50	6.042
204	40	6.449	42	7.260	44	7.671	48	7.551	50	7.217
205	40	4.946	42	6.130	44	7.166	48	7.687	50	7.646
206	40	3.661	42	5.000	44	6.331	48	7.315	50	7.518
207	40	2.857	42	4.128	44	5.554	48	6.748	50	7.121
208	40	2.196	42	3.413	44	4.888	48	6.151	50	6.638
209	39	5.086	41	5.439	43	5.641	47	5.312	49	5.139
210	39	5.932	41	6.453	43	6.759	47	6.387	49	6.197
211	39	6.376	41	7.031	43	7.439	47	7.101	49	6.926
212	39	6.282	41	6.942	43	7.355	47	7.033	49	6.858
213	39	5.730	41	6.195	43	6.451	47	6.061	49	5.861
214	39	5.009	41	5.275	43	5.413	47	5.030	49	4.853
215	40	3.637	42	2.283	44	1.274	48	.693	50	.537
216	40	1.960	42	2.266	44	2.564	48	2.568	50	2.513
217	39	1.683	41	2.002	43	2.189	47	2.237	49	2.242
218	39	.885	41	1.526	43	2.544	47	3.757	49	4.518
219	40	.804	42	.816	44	.872	48	.896	50	.881
220	39	.607	41	.661	43	.694	47	.745	49	.753
225	39	2.565	41	1.521	43	.912	47	.588	49	.489
227	40	5.522	42	3.953	44	2.681	48	1.649	50	1.356
230	39	.334	41	.374	43	.837	47	1.672	49	2.336
231	40	3.542	42	3.641	44	3.622	48	3.316	50	3.096
234	39	3.071	41	3.093	43	3.078	47	2.837	49	2.724
235	39	.570	41	1.172	43	1.293	47	1.383	49	1.424
236	40	.366	42	.671	44	1.169	48	1.710	50	2.052
237	39	.323	41	.725	43	1.056	47	1.779	49	2.273
238	39	.314	41	.366	43	.877	47	1.658	49	2.201
239	40	.292	42	.373	44	.821	48	1.571	50	2.186
244	40	2.617	42	1.402	44	.692	48	.420	50	.355
245	39	2.519	41	1.462	43	.834	47	.454	49	.378
246	40	1.196	42	1.104	44	1.088	48	1.048	50	1.030
247	39	.766	41	.909	43	.992	47	1.015	49	.995
248	40	.769	42	.699	44	.649	48	.606	50	.607
249	39	.574	41	.593	43	.560	47	.537	49	.544

Table VII(continued)

Nominal Conditions: $\beta = -2.0^{\circ}$, $M_{\infty} =$ 6.0, Upright, Pressures in psia

Orifice ID	Nominal α							
	30.0°		35.0°		40.0°		45.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
201	52	2.749	54	2.218	56	1.810	58	1.474
202	52	3.799	54	3.144	56	2.682	58	2.209
203	52	5.336	54	4.670	56	4.043	58	3.345
204	52	6.643	54	6.134	56	5.633	58	4.970
205	52	7.353	54	7.111	56	6.829	58	6.308
206	52	7.435	54	7.435	56	7.390	58	7.106
207	52	7.243	54	7.424	56	7.553	58	7.484
208	52	6.895	54	7.209	56	7.518	58	7.590
209	51	4.831	53	4.339	55	3.939	57	3.473
210	51	5.839	53	5.269	55	4.842	57	4.290
211	51	6.545	53	5.936	55	5.441	57	4.819
212	51	6.458	53	5.851	55	5.348	57	4.751
213	51	5.520	53	4.963	55	4.499	57	3.921
214	51	4.548	53	4.063	55	3.696	57	3.264
215	52	.415	54	.343	56	.305	58	.279
216	52	2.425	54	2.358	56	2.382	58	2.317
217	51	2.119	53	1.951	55	1.873	57	1.753
218	51	5.209	53	5.728	55	6.346	57	6.828
219	52	.839	54	.787	56	.770	58	.764
220	51	.721	53	.673	55	.665	57	.659
225	51	.390	53	.325	55	.295	57	.275
227	52	1.143	54	1.012	56	.991	58	.950
230	51	2.992	53	3.585	55	4.290	57	4.951
231	52	2.820	54	2.583	56	2.354	58	2.096
234	51	2.539	53	2.270	55	2.080	57	1.859
235	51	1.508	53	1.591	55	1.686	57	1.774
236	52	2.347	54	2.666	56	3.029	58	3.305
237	51	2.836	53	3.374	55	4.012	57	4.618
238	51	2.816	53	3.383	55	4.063	57	4.716
239	52	2.719	54	3.345	56	4.069	58	4.752
244	52	.312	54	.287	56	.274	58	.259
245	51	.331	53	.296	55	.284	57	.272
246	52	.998	54	.974	56	.956	58	.926
247	51	.968	53	.944	55	.951	57	.954
248	52	.618	54	.622	56	.625	58	.625
249	51	.552	53	.548	55	.556	57	.557

Table VIII: 20-Inch Mach 6 Air Tunnel - 2% Model
Nominal Conditions: $\beta = -4.0^{\circ}$, $M_{\infty} =$ 6.0, Upright, Pressures in psia

Orifice ID	Nominal α									
	-10.0°		0.0°		10.0°		15.0°		20.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
201	66	7.140	68	6.564	70	5.448	72	4.710	74	3.996
202	66	7.530	68	7.310	70	6.422	72	5.735	74	5.102
203	66	7.453	68	7.768	70	7.410	72	6.939	74	6.473
204	66	6.545	68	7.390	70	7.654	72	7.512	74	7.371
205	66	5.140	68	6.286	70	7.152	72	7.332	74	7.496
206	66	3.926	68	5.145	70	6.348	72	6.753	74	7.154
207	66	3.110	68	4.278	70	5.579	72	6.094	74	6.616
208	66	2.409	68	3.593	70	4.911	72	5.444	74	6.032
209	65	5.372	67	5.743	69	5.928	71	5.781	73	5.559
210	65	6.149	67	6.695	69	6.982	71	6.830	73	6.598
211	65	6.525	67	7.196	69	7.567	71	7.449	73	7.229
212	65	6.154	67	6.858	69	7.240	71	7.115	73	6.899
213	65	5.502	67	5.995	69	6.246	71	6.097	73	5.861
214	65	4.623	67	5.046	69	5.165	71	5.010	73	4.792
215	66	3.214	68	2.242	70	1.270	72	.914	74	.686
216	66	2.230	68	2.618	70	2.800	72	2.796	74	2.764
217	65	1.483	67	1.829	69	1.999	71	2.002	73	2.009
218	65	1.004	67	1.625	69	2.597	71	3.181	73	3.795
219	66	.894	68	.963	70	.985	72	.994	74	.991
220	65	.473	67	.617	69	.658	71	.675	73	.691
225	65	2.177	67	1.434	69	.894	71	.665	73	.560
227	66	5.031	68	3.921	70	2.654	72	2.074	74	1.644
230	65	.325	67	.405	69	.874	71	1.276	73	1.786
231	66	3.858	68	4.001	70	3.897	72	3.708	74	3.509
234	65	2.708	67	2.834	69	2.848	71	2.740	73	2.618
235	65	.733	67	1.232	69	1.384	71	1.429	73	1.496
236	66	.436	68	.659	70	1.118	72	1.406	74	1.853
237	65	.324	67	.777	69	1.103	71	1.414	73	1.842
238	65	.304	67	.416	69	.783	71	1.167	73	1.719
239	66	.295	68	.402	70	.838	72	1.167	74	1.667
244	66	2.199	68	1.321	70	.699	72	.518	74	.428
245	65	2.105	67	1.356	69	.821	71	.560	73	.450
246	66	1.336	68	1.294	70	1.242	72	1.205	74	1.186
247	65	.938	67	1.048	69	1.144	71	1.163	73	1.159
248	66	.841	68	.822	70	.743	72	.705	74	.683
249	65	.466	67	.552	69	.543	71	.518	73	.516

Table VIII(continued)

Nominal Conditions: β = -4.0°, M_{∞} = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α									
	25.0°		30.0°		35.0°		40.0°		45.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
201	76	3.320	78	2.705	80	2.244	82	1.779	84	1.446
202	76	4.457	78	3.789	80	3.209	82	2.667	84	2.244
203	76	5.908	78	5.302	80	4.736	82	4.001	84	3.329
204	76	7.076	78	6.612	80	6.221	82	5.590	84	4.947
205	76	7.499	78	7.316	80	7.201	82	6.778	84	6.275
206	76	7.392	78	7.419	80	7.534	82	7.355	84	7.078
207	76	7.015	78	7.227	80	7.516	82	7.528	84	7.443
208	76	6.541	78	6.885	80	7.297	82	7.481	84	7.552
209	75	5.314	77	4.925	79	4.613	81	4.122	83	3.641
210	75	6.313	77	5.854	79	5.500	81	4.992	83	4.417
211	75	6.954	77	6.474	79	6.109	81	5.527	83	4.895
212	75	6.637	77	6.162	79	5.797	81	5.225	83	4.643
213	75	5.593	77	5.188	79	4.840	81	4.323	83	3.763
214	75	4.556	77	4.211	79	3.910	81	3.572	83	3.106
215	76	.541	78	.424	80	.364	82	.329	84	.305
216	76	2.714	78	2.625	80	2.586	82	2.523	84	2.483
217	75	2.011	77	1.917	79	1.824	81	1.743	83	1.606
218	75	4.508	77	5.112	79	5.799	81	6.374	83	6.822
219	76	.980	78	.939	80	.903	82	.868	84	.843
220	75	.700	77	.682	79	.656	81	.675	83	.641
225	75	.482	77	.397	79	.344	81	.310	83	.292
227	76	1.372	78	1.184	80	1.070	82	1.014	84	1.014
230	75	2.328	77	2.912	79	3.593	81	4.288	83	4.908
231	76	3.283	78	3.012	80	2.814	82	2.516	84	2.233
234	75	2.502	77	2.312	79	2.154	81	1.981	83	1.750
235	75	1.566	77	1.638	79	1.768	81	1.829	83	1.953
236	76	2.195	78	2.520	80	2.886	82	3.208	84	3.489
237	75	2.343	77	2.866	79	3.495	81	4.129	83	4.709
238	75	2.244	77	2.801	79	3.454	81	4.127	83	4.748
239	76	2.173	78	2.725	80	3.386	82	4.069	84	4.723
244	76	.366	78	.323	80	.298	82	.280	84	.271
245	75	.389	77	.344	79	.312	81	.288	83	.279
246	76	1.160	78	1.120	80	1.112	82	1.079	84	1.040
247	75	1.139	77	1.094	79	1.083	81	1.084	83	1.072
248	76	.683	78	.689	80	.707	82	.706	84	.697
249	75	.527	77	.533	79	.535	81	.560	83	.544

Table IX: Data Summary - 20-Inch Mach 6 Air Tunnel - 4% Model

Ref	Run	Point	M_∞	α deg	β deg	ϕ deg	P_{t_1} psia	q_∞ psia	P_∞ psia	P_{t_2} psia
1	2	3718	6.00	.0	0.0	0	244.03	3.895	.155	7.235
2	2	3718	6.00	10.1	0.0	0	251.11	4.008	.159	7.445
3	2	3718	6.00	15.1	0.0	0	249.26	3.978	.158	7.391
4	2	3718	6.00	20.2	0.0	0	248.11	3.960	.157	7.356
5	2	3718	6.00	24.9	0.0	0	248.87	3.972	.158	7.379
6	2	3718	6.00	27.0	0.0	0	247.18	3.945	.157	7.329
7	2	3718	6.00	29.9	0.0	0	247.54	3.951	.157	7.340
8	3	3719	6.00	35.3	−2.0	0	248.42	3.965	.157	7.366
9	3	3719	6.00	31.9	−2.0	0	250.70	4.001	.159	7.433
10	3	3719	6.00	30.0	−2.0	0	255.42	4.076	.162	7.573
11	3	3719	6.00	27.0	−2.0	0	248.42	3.965	.157	7.366
12	3	3719	6.00	24.9	−2.0	0	248.80	3.971	.158	7.377
13	3	3719	6.00	20.1	−2.0	0	255.78	4.082	.162	7.584
14	3	3719	6.00	14.9	−2.0	0	248.42	3.965	.157	7.366
15	3	3719	6.00	9.9	−2.0	0	251.96	4.021	.160	7.471
16	3	3719	6.00	−.1	−2.0	0	245.45	3.917	.156	7.278
17	5	3801	6.00	35.4	−4.0	0	242.98	3.878	.154	7.204
18	5	3801	6.00	32.0	−4.0	0	252.24	4.026	.160	7.479
19	5	3801	6.00	30.0	−4.0	0	254.68	4.065	.161	7.551
20	5	3801	6.00	27.1	−4.0	0	248.22	3.961	.157	7.360
21	5	3801	6.00	24.8	−4.0	0	247.72	3.954	.157	7.345
22	5	3801	6.00	20.1	−4.0	0	256.56	4.095	.163	7.607
23	5	3801	6.00	15.0	−4.0	0	255.09	4.071	.162	7.564
24	5	3801	6.00	10.2	−4.0	0	255.43	4.077	.162	7.573
25	5	3801	6.00	.0	−4.0	0	254.92	4.068	.161	7.558
26	6	3802	6.00	35.4	0.0	0	252.58	4.031	.160	7.489
27	6	3802	6.00	32.2	0.0	0	258.04	4.118	.163	7.651
28	6	3802	6.00	5.0	0.0	0	255.56	4.079	.162	7.577
29	6	3802	6.00	.0	0.0	0	252.74	4.034	.160	7.494
30	6	3802	6.00	−4.9	0.0	0	255.67	4.081	.162	7.581
31	6	3802	6.00	−10.2	0.0	0	250.43	3.997	.159	7.425
32	6	3802	6.00	.0	0.0	0	250.03	3.990	.158	7.413
33	9	3888	6.00	9.9	0.0	180	247.06	3.943	.157	7.325
34	9	3888	6.00	5.1	0.0	180	251.97	4.021	.160	7.471
35	9	3888	6.00	.1	0.0	180	244.73	3.906	.155	7.256
36	9	3888	6.00	−5.1	0.0	180	257.20	4.105	.163	7.626
37	9	3888	6.00	−10.1	0.0	180	251.83	4.019	.160	7.467
38	9	3888	6.00	.0	0.0	180	248.52	3.966	.157	7.369

Table X: 20-Inch Mach 6 Air Tunnel - 4% Model
Nominal Conditions: $\beta = 0.0^{\circ}$, $M_{\infty} = 6.0$, Inverted, Pressures in psia

Ori-	Nominal α									
fice	-10.0°		-5.0°		0.0°		5.0°		10.0°	
ID	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
2	37	.621	36	.884	35	1.173	34	1.630	33	2.080
5	37	1.667	36	1.753	35	1.662	34	1.741	33	1.773
9	37	3.271	36	2.608	35	1.908	34	1.486	33	1.068
10	37	.602	36	.787	35	.994	34	1.347	33	1.763
13	37	1.523	36	1.546	35	1.488	34	1.529	33	1.489
14	37	1.505	36	1.526	35	1.471	34	1.503	33	1.454
17	37	3.163	36	2.467	35	1.737	34	1.251	33	.867
19	37	1.207	36	1.237	35	1.076	34	1.094	33	1.069
20	37	1.173	36	1.172	35	1.085	34	1.100	33	1.070
21	37	.712	36	.707	35	.684	34	.718	33	.711
22	37	.829	36	.803	35	.772	34	.806	33	.793
23	37	.820	36	.800	35	.751	34	.761	33	.750
24	37	.901	36	.871	35	.837	34	.851	33	.838
25	37	.740	36	.726	35	.685	34	.682	33	.659
26	37	1.983	36	1.977	35	1.967	34	1.958	33	1.925
43	37	1.059	36	1.222	35	1.297	34	1.472	33	1.564
44	37	1.066	36	1.221	35	1.289	34	1.448	33	1.538
85	37	2.182	36	2.290	35	2.209	34	2.306	33	2.332
86	37	2.184	36	2.292	35	2.209	34	2.300	33	2.321
87	37	.874	36	1.172	35	1.429	34	1.859	33	2.267
88	37	.871	36	1.168	35	1.427	34	1.857	33	2.268
89	37	.205	36	.272	35	.359	34	.529	33	.759
90	37	.185	36	.247	35	.337	34	.509	33	.747
91	37	.135	36	.194	35	.281	34	.457	33	.696
921	37	3.620	36	2.981	35	2.222	34	1.748	33	1.276
922	37	.775	36	1.082	35	1.398	34	1.910	33	2.387
93	37	.389	36	.551	35	.750	34	1.081	33	1.437
128	37	2.561	36	1.974	35	1.361	34	.998	33	.714
201	37	7.153	36	6.775	35	6.045	34	5.655	33	4.830
202	37	7.555	36	7.542	35	7.071	34	7.001	33	6.312
203	37	7.330	36	7.627	35	7.418	34	7.708	33	7.270
204	37	6.534	36	7.085	35	7.167	34	7.696	33	7.542
205	37	4.793	36	5.574	35	6.060	34	6.892	33	7.129
206	37	3.786	36	4.568	35	5.124	34	5.970	33	6.381
207	37	3.020	36	3.720	35	4.258	34	5.056	33	5.523
208	37	2.041	36	2.593	35	3.051	34	3.780	33	4.322

Table X(continued)

Nominal Conditions: $\beta = 0.0^{\circ}$, $M_{\infty} = 6.0$, Inverted, Pressures in psia

Orifice ID	Nominal α									
	-10.0°		-5.0°		0.0°		5.0°		10.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	37	4.977	36	5.386	35	5.344	34	5.600	33	5.447
210	37	5.551	36	6.045	35	6.064	34	6.433	33	6.349
211	37	6.130	36	6.732	35	6.805	34	7.271	33	7.222
212	37	6.161	36	6.716	35	6.787	34	7.228	33	7.207
213	37	5.583	36	6.037	35	6.042	34	6.389	33	6.333
214	37	4.979	36	5.351	35	5.303	34	5.554	33	5.449
215	37	3.514	36	2.910	35	2.160	34	1.698	33	1.264
216	37	1.748	36	1.911	35	1.945	34	2.113	33	2.156
217	37	1.732	36	1.921	35	1.926	34	2.101	33	2.188
218	37	.865	36	1.106	35	1.340	34	1.815	33	2.334
219	37	.636	36	.675	35	.680	34	.715	33	.717
220	37	.617	36	.640	35	.633	34	.675	33	.681
225	37	2.260	36	1.740	35	1.217	34	.901	33	.639
226	37	4.762	36	4.116	35	3.230	34	2.677	33	2.075
227	37	5.206	36	4.591	35	3.739	34	3.197	33	2.557
228	37	6.456	36	6.058	35	5.187	34	4.639	33	3.822
229	37	1.271	36	1.682	35	2.069	34	2.715	33	3.260
230	37	.247	36	.337	35	.461	34	.687	33	.959
231	37	3.300	36	3.426	35	3.334	34	3.441	33	3.288
232	37	4.534	36	4.831	35	4.749	34	4.928	33	4.787
233	37	4.608	36	4.868	35	4.736	34	4.895	33	4.740
234	37	3.337	36	3.426	35	3.327	34	3.430	33	3.277
235	37	.449	36	.567	35	.642	34	.789	33	.925
236	37	.289	36	.417	35	.544	34	.760	33	1.008
238	37	.408	36	.489	35	.599	34	.809	33	1.073
239	37	.389	36	.464	35	.574	34	.781	33	1.048
245	37	2.228	36	1.690	35	1.218	34	.922	33	.685
246	37	1.356	36	1.298	35	1.169	34	1.179	33	1.162
247	37	.837	36	.912	35	.908	34	.969	33	1.005
248	37	.831	36	.818	35	.767	34	.753	33	.712
249	37	.849	36	.825	35	.776	34	.760	33	.714

Table XI: 20-Inch Mach 6 Air Tunnel - 4% Model
Nominal Conditions: $\beta = 0.0^{\circ}$, $M_{\infty} = 6.0$, Upright, Pressures in psia

Orifice ID	Nominal α											
	-10.0°		-5.0°		0.0°		5.0°		10.0°		15.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
2	31	.605	30	.867	1	1.134	28	1.639	2	2.114	3	2.671
5	31	1.663	30	1.722	1	1.707	28	1.756	2	1.730	3	1.655
9	31	3.253	30	2.604	1	1.936	28	1.527	2	1.066	3	.770
10	31	.594	30	.775	1	.975	28	1.341	2	1.756	3	2.204
13	31	1.504	30	1.536	1	1.481	28	1.524	2	1.491	3	1.477
14	31	1.501	30	1.529	1	1.473	28	1.522	2	1.459	3	1.442
17	31	3.166	30	2.497	1	1.796	28	1.271	2	.850	3	.609
19	31	1.183	30	1.225	1	1.101	28	1.095	2	1.074	3	1.071
20	31	1.201	30	1.186	1	1.094	28	1.103	2	1.063	3	1.075
21	31	.711	30	.705	1	.674	28	.726	2	.719	3	.717
22	31	.833	30	.814	1	.774	28	.813	2	.793	3	.789
23	31	.815	30	.795	1	.751	28	.761	2	.752	3	.754
24	31	.901	30	.882	1	.835	28	.855	2	.832	3	.849
25	31	.736	30	.721	1	.679	28	.685	2	.658	3	.655
26	31	1.972	30	1.954	1	1.904	28	1.941	2	1.916	3	1.908
43	31	1.039	30	1.210	1	1.310	28	1.490	2	1.586	3	1.646
44	31	1.061	30	1.226	1	1.310	28	1.489	2	1.549	3	1.596
85	31	2.168	30	2.265	1	2.243	28	2.342	2	2.304	3	2.216
86	31	2.189	30	2.285	1	2.234	28	2.353	2	2.290	3	2.198
87	31	.848	30	1.151	1	1.428	28	1.886	2	2.273	3	2.654
88	31	.852	30	1.155	1	1.437	28	1.895	2	2.273	3	2.645
89	31	.207	30	.275	1	.359	28	.530	2	.760	3	1.062
90	31	.185	30	.249	1	.336	28	.507	2	.742	3	1.046
91	31	.136	30	.195	1	.282	28	.453	2	.698	3	1.009
921	31	3.613	30	2.956	1	2.232	28	1.800	2	1.281	3	.934
922	31	.751	30	1.061	1	1.362	28	1.927	2	2.422	3	3.011
93	31	.386	30	.549	1	.721	28	1.073	2	1.457	3	1.928
128	31	2.619	30	1.985	1	1.386	28	1.022	2	.709	3	.537
201	31	7.149	30	6.834	1	6.073	28	5.575	2	4.749	3	4.167
202	31	7.542	30	7.590	1	7.063	28	6.893	2	6.209	3	5.771
203	31	7.289	30	7.657	1	7.377	28	7.610	2	7.142	3	6.903
204	31	6.462	30	7.110	1	7.107	28	7.633	2	7.421	3	7.414
205	31	4.687	30	5.612	1	6.016	28	6.859	2	7.057	3	7.324
206	31	3.673	30	4.583	1	5.132	28	5.974	2	6.355	3	6.762
207	31	2.920	30	3.711	1	4.269	28	5.059	2	5.533	3	6.022
208	31	1.965	30	2.574	1	3.058	28	3.778	2	4.365	3	4.994

Table XI(continued)

Nominal Conditions: $\beta =$ 0.0°, $M_\infty =$ 6.0, Upright, Pressures in psia

Ori-	Nominal α											
fice	-10.0°		-5.0°		0.0°		5.0°		10.0°		15.0°	
ID	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	31	4.911	30	5.360	1	5.331	28	5.621	2	5.438	3	5.293
210	31	5.469	30	6.019	1	6.001	28	6.467	2	6.312	3	6.197
211	31	6.058	30	6.713	1	6.696	28	7.311	2	7.164	3	7.059
212	31	6.112	30	6.746	1	6.692	28	7.318	2	7.164	3	7.037
213	31	5.537	30	6.054	1	5.967	28	6.472	2	6.307	3	6.142
214	31	4.941	30	5.362	1	5.302	28	5.629	2	5.425	3	5.233
215	31	3.511	30	2.876	1	2.207	28	1.774	2	1.281	3	.931
216	31	1.721	30	1.904	1	1.975	28	2.144	2	2.169	3	2.154
217	31	1.728	30	1.919	1	1.975	28	2.168	2	2.185	3	2.143
218	31	.997	30	1.189	1	1.896	28	2.012	2	2.521	3	3.049
219	31	.631	30	.670	1	.685	28	.723	2	.724	3	.723
220	31	.625	30	.646	1	.653	28	.696	2	.691	3	.689
225	31	2.283	30	1.768	1	1.243	28	.918	2	.634	3	.473
226	31	4.780	30	4.091	1	3.234	28	2.721	2	2.098	3	1.613
227	31	5.233	30	4.567	1	3.733	28	3.238	2	2.590	3	2.049
228	31	6.473	30	6.025	1	5.196	28	4.660	2	3.848	3	3.160
229	31	1.229	30	1.655	1	2.049	28	2.719	2	3.299	3	3.961
230	31	.246	30	.338	1	.452	28	.681	2	.961	3	1.337
231	31	3.265	30	3.423	1	3.306	28	3.418	2	3.267	3	3.180
232	31	4.498	30	4.838	1	4.752	28	4.981	2	4.774	3	4.576
233	31	4.585	30	4.860	1	4.768	28	4.957	2	4.717	3	4.502
234	31	3.322	30	3.452	1	3.301	28	3.432	2	3.242	3	3.175
235	31	.443	30	.557	1	.647	28	.793	2	.919	3	1.025
236	31	.284	30	.415	1	.546	28	.756	2	.995	3	1.238
238	31	.405	30	.488	1	.592	28	.803	2	1.072	3	1.420
239	31	.386	30	.464	1	.566	28	.776	2	1.046	3	1.397
245	31	2.283	30	1.736	1	1.240	28	.943	2	.698	3	.574
246	31	1.375	30	1.276	1	1.181	28	1.186	2	1.153	3	1.114
247	31	.826	30	.898	1	.918	28	.975	2	.998	3	.983
248	31	.827	30	.811	1	.763	28	.757	2	.714	3	.685
249	31	.851	30	.825	1	.766	28	.772	2	.714	3	.683

Table XI: 20-Inch Mach 6 Air Tunnel - 4% Model(continued)
Nominal Conditions: $\beta =$ 0.0°, $M_\infty =$ 6.0, Upright, Pressures in psia

Orifice ID	Nominal α											
	20.0°		25.0°		27.0°		30.0°		32.0°		35.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
2	4	3.331	5	3.933	6	4.153	7	4.561	27	5.224	26	5.557
5	4	1.606	5	1.505	6	1.473	7	1.392	27	1.441	26	1.348
9	4	.543	5	.416	6	.356	7	.314	27	.298	26	.256
10	4	2.817	5	3.380	6	3.686	7	3.996	27	4.641	26	5.046
13	4	1.437	5	1.394	6	1.347	7	1.300	27	1.332	26	1.257
14	4	1.405	5	1.361	6	1.317	7	1.267	27	1.322	26	1.241
17	4	.405	5	.313	6	.275	7	.247	27	.239	26	.214
19	4	1.067	5	1.060	6	1.030	7	1.004	27	1.025	26	.964
20	4	1.049	5	1.046	6	1.000	7	.991	27	1.022	26	.961
21	4	.733	5	.745	6	.731	7	.722	27	.746	26	.713
22	4	.785	5	.795	6	.773	7	.764	27	.793	26	.753
23	4	.761	5	.773	6	.763	7	.762	27	.777	26	.751
24	4	.838	5	.858	6	.848	7	.847	27	.869	26	.838
25	4	.673	5	.688	6	.685	7	.688	27	.715	26	.694
26	4	1.929	5	1.933	6	1.942	7	1.941	27	1.925	26	1.903
43	4	1.719	5	1.777	6	1.824	7	1.846	27	1.953	26	1.936
44	4	1.651	5	1.688	6	1.724	7	1.722	27	1.842	26	1.814
85	4	2.144	5	2.041	6	2.006	7	1.902	27	1.960	26	1.837
86	4	2.135	5	2.017	6	1.975	7	1.863	27	1.937	26	1.810
87	4	3.083	5	3.476	6	3.715	7	3.907	27	4.332	26	4.485
88	4	3.059	5	3.444	6	3.674	7	3.840	27	4.309	26	4.450
89	4	1.491	5	1.962	6	2.228	7	2.520	27	3.007	26	3.381
90	4	1.483	5	1.954	6	2.214	7	2.499	27	3.008	26	3.383
91	4	1.450	5	1.940	6	2.214	7	2.525	27	3.022	26	3.423
921	4	.670	5	.510	6	.434	7	.378	27	.356	26	.301
922	4	3.678	5	4.309	6	4.554	7	5.024	27	5.659	26	5.953
93	4	2.506	5	3.105	6	3.388	7	3.782	27	4.346	26	4.735
128	4	.437	5	.393	6	.378	7	.370	27	.384	26	.371
201	4	3.358	5	2.856	6	2.560	7	2.293	27	2.176	26	1.861
202	4	4.997	5	4.506	6	4.094	7	3.846	27	3.787	26	3.321
203	4	6.282	5	5.821	6	5.345	7	5.157	27	5.218	26	4.678
204	4	7.118	5	6.814	6	6.359	7	6.253	27	6.483	26	5.936
205	4	7.407	5	7.384	6	7.182	7	7.071	27	7.531	26	7.168
206	4	7.100	5	7.318	6	7.258	7	7.216	27	7.815	26	7.680
207	4	6.513	5	6.944	6	6.947	7	7.033	27	7.705	26	7.701
208	4	5.658	5	6.279	6	6.358	7	6.663	27	7.282	26	7.398

Table XI(continued)

Nominal Conditions: $\beta =$ 0.0°, $M_\infty =$ 6.0, Upright, Pressures in psia

Orifice ID	Nominal α											
	20.0°		25.0°		27.0°		30.0°		32.0°		35.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	4	5.058	5	4.747	6	4.498	7	4.390	27	4.440	26	4.059
210	4	6.002	5	5.655	6	5.405	7	5.275	27	5.382	26	4.959
211	4	6.856	5	6.482	6	6.202	7	6.001	27	6.185	26	5.685
212	4	6.835	5	6.466	6	6.179	7	5.971	27	6.223	26	5.753
213	4	5.923	5	5.579	6	5.336	7	5.169	27	5.336	26	4.913
214	4	5.001	5	4.682	6	4.532	7	4.349	27	4.443	26	4.079
215	4	.693	5	.529	6	.467	7	.402	27	.377	26	.319
216	4	2.124	5	2.075	6	2.067	7	1.999	27	2.047	26	1.963
217	4	2.125	5	2.038	6	2.015	7	1.921	27	2.028	26	1.941
218	4	3.709	5	4.302	6	4.650	7	4.949	27	5.641	26	6.046
219	4	.716	5	.677	6	.657	7	.618	27	.626	26	.608
220	4	.683	5	.646	6	.625	7	.581	27	.598	26	.573
225	4	.378	5	.333	6	.314	7	.302	27	.306	26	.300
226	4	1.192	5	.912	6	.785	7	.663	27	.624	26	.514
227	4	1.543	5	1.208	6	1.047	7	.880	27	.833	26	.684
228	4	2.459	5	1.975	6	1.738	7	1.497	27	1.418	26	1.178
229	4	4.631	5	5.296	6	5.467	7	5.901	27	6.504	26	6.702
230	4	1.851	5	2.400	6	2.692	7	3.050	27	3.555	26	3.954
231	4	3.011	5	2.858	6	2.715	7	2.619	27	2.687	26	2.491
232	4	4.347	5	4.062	6	3.934	7	3.790	27	3.830	26	3.518
233	4	4.282	5	3.995	6	3.896	7	3.707	27	3.771	26	3.470
234	4	2.989	5	2.845	6	2.647	7	2.594	27	2.682	26	2.481
235	4	1.170	5	1.290	6	1.359	7	1.409	27	1.565	26	1.616
236	4	1.575	5	1.879	6	2.041	7	2.202	27	2.532	26	2.719
238	4	1.896	5	2.414	6	2.710	7	3.048	27	3.543	26	3.932
239	4	1.878	5	2.404	6	2.706	7	3.048	27	3.577	26	3.990
245	4	.500	5	.460	6	.441	7	.429	27	.433	26	.428
246	4	1.098	5	1.089	6	1.098	7	1.076	27	1.115	26	1.079
247	4	.939	5	.906	6	.916	7	.910	27	.959	26	.954
248	4	.674	5	.685	6	.688	7	.710	27	.749	26	.740
249	4	.670	5	.678	6	.681	7	.697	27	.746	26	.738

Table XII: 20-Inch Mach 6 Air Tunnel - 4% Model
Nominal Conditions: β = -2.0°, M_∞ = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α									
	0.0°		10.0°		15.0°		20.0°		25.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
2	16	1.132	15	2.110	14	2.670	13	3.407	12	3.974
5	16	1.887	15	1.932	14	1.841	13	1.811	12	1.713
9	16	1.947	15	1.057	14	.764	13	.570	12	.417
10	16	.978	15	1.758	14	2.206	13	2.852	12	3.457
13	16	1.668	15	1.654	14	1.656	13	1.675	12	1.574
14	16	1.308	15	1.296	14	1.296	13	1.308	12	1.230
17	16	1.766	15	.863	14	.606	13	.426	12	.312
19	16	1.225	15	1.205	14	1.214	13	1.256	12	1.206
20	16	.962	15	.934	14	.941	13	.971	12	.934
21	16	.786	15	.840	14	.830	13	.861	12	.861
22	16	.662	15	.685	14	.684	13	.712	12	.701
23	16	.855	15	.860	14	.867	13	.898	12	.884
24	16	.667	15	.659	14	.670	13	.694	12	.693
25	16	.777	15	.757	14	.751	13	.784	12	.792
26	16	1.935	15	1.925	14	1.915	13	1.923	12	1.919
43	16	1.442	15	1.794	14	1.855	13	2.015	12	2.013
44	16	1.125	15	1.377	14	1.416	13	1.534	12	1.523
85	16	2.446	15	2.554	14	2.445	13	2.424	12	2.286
86	16	2.013	15	2.089	14	2.005	13	1.983	12	1.871
87	16	1.493	15	2.436	14	2.829	13	3.430	12	3.743
88	16	1.293	15	2.119	14	2.469	13	2.994	12	3.297
89	16	.355	15	.774	14	1.084	13	1.575	12	2.037
90	16	.319	15	.712	14	1.009	13	1.472	12	1.933
91	16	.261	15	.680	14	.992	13	1.496	12	1.955
921	16	2.233	15	1.270	14	.926	13	.701	12	.512
922	16	1.359	15	2.418	14	3.017	13	3.797	12	4.355
93	16	.715	15	1.457	14	1.922	13	2.594	12	3.143
128	16	1.386	15	.717	14	.545	13	.456	12	.396
201	16	5.984	15	4.653	14	4.044	13	3.480	12	2.789
202	16	7.002	15	6.117	14	5.659	13	5.241	12	4.498
203	16	7.345	15	7.032	14	6.800	13	6.567	12	5.822
204	16	7.077	15	7.311	14	7.337	13	7.419	12	6.822
205	16	5.952	15	6.933	14	7.284	13	7.709	12	7.405
206	16	5.032	15	6.229	14	6.747	13	7.391	12	7.352
207	16	4.169	15	5.412	14	6.010	13	6.809	12	6.973
208	16	2.988	15	4.283	14	4.981	13	5.922	12	6.307

Table XII(continued)

Nominal Conditions: β = -2.0°, M_∞ = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α									
	0.0°		10.0°		15.0°		20.0°		25.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	16	5.511	15	5.658	14	5.516	13	5.507	12	4.993
210	16	6.173	15	6.516	14	6.381	13	6.368	12	5.883
211	16	6.808	15	7.298	14	7.159	13	7.106	12	6.633
212	16	6.530	15	7.057	14	6.903	13	6.858	12	6.425
213	16	5.693	15	6.082	14	5.906	13	5.866	12	5.445
214	16	4.938	15	5.165	14	4.963	13	4.928	12	4.493
215	16	2.159	15	1.294	14	.926	13	.711	12	.524
216	16	2.122	15	2.408	14	2.370	13	2.453	12	2.315
217	16	1.738	15	1.957	14	1.919	13	1.942	12	1.864
218	16	1.480	15	2.527	14	3.065	13	3.811	12	4.390
219	16	.774	15	.845	14	.839	13	.873	12	.810
220	16	.517	15	.575	14	.569	13	.592	12	.532
225	16	1.238	15	.621	14	.457	13	.378	12	.325
226	16	3.208	15	2.072	14	1.606	13	1.243	12	.921
227	16	3.693	15	2.562	14	2.049	13	1.613	12	1.218
228	16	5.126	15	3.825	14	3.167	13	2.581	12	1.989
229	16	2.030	15	3.279	14	3.955	13	4.840	12	5.340
230	16	.447	15	.959	14	1.334	13	1.926	12	2.430
231	16	3.591	15	3.492	14	3.428	13	3.398	12	3.115
232	16	4.947	15	5.082	14	4.859	13	4.791	12	4.379
233	16	4.422	15	4.498	14	4.270	13	4.213	12	3.814
234	16	3.075	15	2.971	14	2.913	13	2.879	12	2.640
235	16	.731	15	1.049	14	1.168	13	1.353	12	1.482
236	16	.595	15	1.095	14	1.360	13	1.747	12	2.088
238	16	.602	15	1.100	14	1.454	13	2.023	12	2.498
239	16	.566	15	1.051	14	1.404	13	1.967	12	2.452
245	16	1.143	15	.527	14	.375	13	.302	12	.248
246	16	1.310	15	1.313	14	1.282	13	1.288	12	1.244
247	16	1.027	15	1.147	14	1.131	13	1.126	12	1.054
248	16	.877	15	.818	14	.784	13	.789	12	.782
249	16	.683	15	.641	14	.612	13	.614	12	.617

Table XII: 20-Inch Mach 6 Air Tunnel - 4% Model(continued)
Nominal Conditions: $\beta = -2.0^{\circ}$, $M_{\infty} =$ 6.0, Upright, Pressures in psia

Orifice ID	Nominal α							
	27.0°		30.0°		32.0°		35.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
2	11	4.263	10	4.857	9	5.085	8	5.360
5	11	1.674	10	1.612	9	1.603	8	1.510
9	11	.368	10	.325	9	.287	8	.257
10	11	3.749	10	4.184	9	4.556	8	5.024
13	11	1.543	10	1.546	9	1.449	8	1.387
14	11	1.205	10	1.206	9	1.139	8	1.076
17	11	.280	10	.254	9	.229	8	.214
19	11	1.196	10	1.204	9	1.155	8	1.084
20	11	.913	10	.917	9	.868	8	.855
21	11	.863	10	.877	9	.851	8	.798
22	11	.693	10	.693	9	.662	8	.647
23	11	.890	10	.913	9	.891	8	.848
24	11	.685	10	.693	9	.662	8	.669
25	11	.796	10	.826	9	.810	8	.781
26	11	1.919	10	1.913	9	1.899	8	1.879
43	11	2.046	10	2.143	9	2.115	8	2.121
44	11	1.545	10	1.609	9	1.587	8	1.594
85	11	2.236	10	2.161	9	2.141	8	2.038
86	11	1.827	10	1.752	9	1.739	8	1.639
87	11	3.952	10	4.348	9	4.445	8	4.714
88	11	3.490	10	3.812	9	3.947	8	4.170
89	11	2.295	10	2.701	9	2.984	8	3.449
90	11	2.181	10	2.556	9	2.854	8	3.298
91	11	2.214	10	2.663	9	2.911	8	3.381
921	11	.450	10	.395	9	.342	8	.300
922	11	4.676	10	5.313	9	5.524	8	5.756
93	11	3.435	10	3.977	9	4.169	8	4.538
128	11	.385	10	.383	9	.383	8	.386
201	11	2.518	10	2.305	9	2.031	8	1.783
202	11	4.200	10	4.029	9	3.658	8	3.332
203	11	5.551	10	5.443	9	4.971	8	4.637
204	11	6.619	10	6.623	9	6.113	8	5.797
205	11	7.335	10	7.541	9	7.070	8	6.937
206	11	7.382	10	7.727	9	7.419	8	7.390
207	11	7.091	10	7.536	9	7.439	8	7.396
208	11	6.521	10	7.055	9	7.086	8	7.121

Table XII(continued)

Nominal Conditions: β = -2.0°, M_∞ = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α							
	27.0°		30.0°		32.0°		35.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	11	4.847	10	4.821	9	4.605	8	4.138
210	11	5.726	10	5.713	9	5.487	8	4.954
211	11	6.466	10	6.421	9	6.175	8	5.567
212	11	6.260	10	6.232	9	5.945	8	5.397
213	11	5.284	10	5.245	9	4.986	8	4.511
214	11	4.358	10	4.288	9	4.061	8	3.672
215	11	.465	10	.406	9	.358	8	.297
216	11	2.283	10	2.292	9	2.200	8	2.118
217	11	1.838	10	1.788	9	1.797	8	1.736
218	11	4.715	10	5.163	9	5.535	8	5.951
219	11	.785	10	.760	9	.723	8	.700
220	11	.509	10	.494	9	.470	8	.456
225	11	.311	10	.302	9	.292	8	.289
226	11	.809	10	.700	9	.600	8	.506
227	11	1.078	10	.937	9	.809	8	,667
228	11	1.796	10	1.587	9	1.398	8	1.143
229	11	5.629	10	6.228	9	6.358	8	6.489
230	11	2.703	10	3.206	9	3.407	8	3.823
231	11	3.028	10	3.019	9	2.788	8	2.659
232	11	4.255	10	4.198	9	3.992	8	3.638
233	11	3.694	10	3.623	9	3.430	8	3.147
234	11	2.555	10	2.543	9	2.350	8	2.252
235	11	1.551	10	1.640	9	1.734	8	1.822
236	11	2.254	10	2.496	9	2.703	8	2.936
238	11	2.775	10	3.272	9	3.483	8	3.971
239	11	2.732	10	3.232	9	3.462	8	3.973
245	11	.230	10	.218	9	.204	8	.203
246	11	1.242	10	1.254	9	1.233	8	1.212
247	11	1.051	10	1.066	9	1.075	8	1.084
248	11	.792	10	.835	9	.837	8	.823
249	11	.630	10	.658	9	.658	8	.647

Table XIII: 20-Inch Mach 6 Air Tunnel - 4% Model
Nominal Conditions: β = -4.0°, M_∞ = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α 0.0° Ref	0.0° Pi	10.0° Ref	10.0° Pi	15.0° Ref	15.0° Pi	20.0° Ref	20.0° Pi	25.0° Ref	25.0° Pi
2	25	1.169	24	2.133	23	2.706	22	3.404	21	3.894
5	25	2.126	24	2.143	23	2.096	22	2.055	21	1.918
9	25	1.995	24	1.062	23	.777	22	.565	21	.405
10	25	.985	24	1.764	23	2.239	22	2.871	21	3.423
13	25	1.916	24	1.889	23	1.876	22	1.849	21	1.716
14	25	1.189	24	1.174	23	1.168	22	1.151	21	1.079
17	25	1.814	24	.850	23	.620	22	.420	21	.305
19	25	1.401	24	1.384	23	1.388	22	1.395	21	1.337
20	25	.860	24	.836	23	.841	22	.842	21	.801
21	25	.960	24	.981	23	.982	22	.998	21	.978
22	25	.586	24	.602	23	.605	22	.618	21	.601
23	25	.995	24	.987	23	1.001	22	1.013	21	.988
24	25	.699	24	.689	23	.697	22	.706	21	.698
25	25	.909	24	.865	23	.865	22	.892	21	.890
26	25	1.920	24	1.899	23	1.888	22	1.888	21	1.887
43	25	1.689	24	2.017	23	2.119	22	2.234	21	2.227
44	25	1.031	24	1.214	23	1.276	22	1.346	21	1.345
85	25	2.751	24	2.790	23	2.736	22	2.681	21	2.499
86	25	1.843	24	1.872	23	1.843	22	1.810	21	1.695
87	25	1.664	24	2.604	23	3.065	22	3.592	21	3.925
88	25	1.241	24	1.975	23	2.348	22	2.786	21	3.076
89	25	.375	24	.805	23	1.136	22	1.610	21	2.064
90	25	.322	24	.700	23	1.000	22	1.438	21	1.863
91	25	.274	24	.693	23	1.015	22	1.483	21	1.936
921	25	2.285	24	1.276	23	.941	22	.691	21	.498
922	25	1.402	24	2.450	23	3.060	22	3.771	21	4.273
93	25	.742	24	1.473	23	1.953	22	2.572	21	3.092
128	25	1.421	24	.713	23	.545	22	.439	21	.377
201	25	6.134	24	4.758	23	4.148	22	3.453	21	2.756
202	25	7.179	24	6.234	23	5.787	22	5.179	21	4.366
203	25	7.531	24	7.175	23	6.938	22	6.475	21	5.636
204	25	7.234	24	7.465	23	7.463	22	7.305	21	6.607
205	25	6.104	24	7.084	23	7.387	22	7.589	21	7.195
206	25	5.179	24	6.377	23	6.834	22	7.265	21	7.165
207	25	4.294	24	5.548	23	6.085	22	6.689	21	6.810
208	25	3.087	24	4.387	23	5.052	22	5.790	21	6.171

Table XIII(continued)

Nominal Conditions: β = -4.0°, M_{∞} = 6.0, Upright, Pressures in psia

Orifice ID	Nominal α									
	0.0°		10.0°		15.0°		20.0°		25.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	25	5.956	24	5.957	23	5.863	22	5.681	21	5.159
210	25	6.591	24	6.770	23	6.716	22	6.567	21	6.008
211	25	7.135	24	7.420	23	7.388	22	7.263	21	6.674
212	25	6.603	24	6.895	23	6.877	22	6.778	21	6.252
213	25	5.665	24	5.840	23	5.793	22	5.678	21	5.198
214	25	4.858	24	4.899	23	4.816	22	4.665	21	4.239
215	25	2.254	24	1.283	23	.952	22	.716	21	.528
216	25	2.454	24	2.659	23	2.677	22	2.686	21	2.545
217	25	1.583	24	1.743	23	1.758	22	1.760	21	1.678
218	25	1.522	24	2.559	23	3.147	22	3.875	21	4.392
219	25	.964	24	.999	23	1.011	22	1.025	21	.964
220	25	.458	24	.488	23	.497	22	.496	21	.443
225	25	1.270	24	.629	23	.471	22	.379	21	.324
226	25	3.286	24	2.091	23	1.624	22	1.224	21	.897
227	25	3.787	24	2.583	23	2.074	22	1.589	21	1.194
228	25	5.250	24	3.846	23	3.207	22	2.541	21	1.963
229	25	2.095	24	3.328	23	4.005	22	4.743	21	5.228
230	25	.462	24	.975	23	1.358	22	1.903	21	2.387
231	25	3.962	24	3.838	23	3.756	22	3.623	21	3.272
232	25	5.367	24	5.317	23	5.202	22	5.041	21	4.598
233	25	4.299	24	4.204	23	4.075	22	3.917	21	3.556
234	25	2.905	24	2.793	23	2.724	22	2.616	21	2.350
235	25	.857	24	1.206	23	1.365	22	1.552	21	1.660
236	25	.671	24	1.220	23	1.531	22	1.935	21	2.257
238	25	.623	24	1.133	23	1.509	22	2.038	21	2.515
239	25	.576	24	1.063	23	1.428	22	1.943	21	2.426
245	25	1.262	24	.701	23	.575	22	.498	21	.447
246	25	1.524	24	1.474	23	1.447	22	1.440	21	1.388
247	25	1.188	24	1.297	23	1.312	22	1.296	21	1.205
248	25	1.024	24	.933	23	.902	22	.892	21	.874
249	25	.615	24	.569	23	.551	22	.547	21	.549

Table XIII: 20-Inch Mach 6 Air Tunnel - 4% Model(continued)
Nominal Conditions: $\beta = -4.0^{\circ}$, $M_{\infty} =$ 6.0, Upright, Pressures in psia

Orifice ID	Nominal α							
	27.0°		30.0°		32.0°		35.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
2	20	4.245	19	4.756	18	4.992	17	5.280
5	20	1.831	19	1.774	18	1.789	17	1.635
9	20	.362	19	.324	18	.286	17	.243
10	20	3.662	19	4.088	18	4.531	17	4.792
13	20	1.709	19	1.699	18	1.622	17	1.523
14	20	1.071	19	1.053	18	1.004	17	.942
17	20	.278	19	.251	18	.228	17	.202
19	20	1.338	19	1.337	18	1.286	17	1.206
20	20	.799	19	.795	18	.758	17	.716
21	20	.986	19	.997	18	.973	17	.905
22	20	.598	19	.594	18	.571	17	.543
23	20	.997	19	1.020	18	.999	17	.951
24	20	.698	19	.700	18	.680	17	.654
25	20	.898	19	.917	18	.912	17	.877
26	20	1.882	19	1.876	18	1.864	17	1.841
43	20	2.252	19	2.348	18	2.351	17	2.286
44	20	1.358	19	1.418	18	1.420	17	1.380
85	20	2.403	19	2.350	18	2.337	17	2.144
86	20	1.624	19	1.574	18	1.566	17	1.428
87	20	4.117	19	4.521	18	4.699	17	4.769
88	20	3.231	19	3.547	18	3.719	17	3.770
89	20	2.310	19	2.732	18	3.044	17	3.357
90	20	2.089	19	2.466	18	2.779	17	3.077
91	20	2.188	19	2.630	18	2.918	17	3.249
921	20	.441	19	.390	18	.341	17	.284
922	20	4.660	19	5.192	18	5.401	17	5.655
93	20	3.408	19	3.912	18	4.165	17	4.485
128	20	.361	19	.340	18	.331	17	.289
201	20	2.568	19	2.355	18	2.093	17	1.766
202	20	4.197	19	4.016	18	3.642	17	3.144
203	20	5.474	19	5.388	18	4.989	17	4.429
204	20	6.496	19	6.547	18	6.170	17	5.634
205	20	7.272	19	7.417	18	7.149	17	6.830
206	20	7.347	19	7.560	18	7.446	17	7.311
207	20	7.063	19	7.367	18	7.312	17	7.305
208	20	6.484	19	6.901	18	6.925	17	7.033

Table XIII(continued)

Nominal Conditions: $\beta = -4.0^{\circ}$, $M_{\infty} =$ 6.0, Upright, Pressures in psia

Ori- fice ID	Nominal α							
	27.0°		30.0°		32.0°		35.0°	
	Ref	Pi	Ref	Pi	Ref	Pi	Ref	Pi
209	20	5.047	19	4.949	18	4.716	17	4.294
210	20	5.900	19	5.789	18	5.548	17	5.050
211	20	6.544	19	6.417	18	6.162	17	5.578
212	20	6.112	19	6.025	18	5.803	17	5.258
213	20	5.059	19	4.977	18	4.775	17	4.304
214	20	4.105	19	4.023	18	3.845	17	3.454
215	20	.464	19	.405	18	.361	17	.297
216	20	2.496	19	2.501	18	2.443	17	2.290
217	20	1.623	19	1.597	18	1.620	17	1.639
218	20	4.653	19	5.293	18	5.763	17	5.950
219	20	.932	19	.910	18	.873	17	.810
220	20	.418	19	.408	18	.399	17	.378
225	20	.313	19	.303	18	.294	17	.284
226	20	.796	19	.688	18	.599	17	.488
227	20	1.065	19	.918	18	.801	17	.650
228	20	1.780	19	1.554	18	1.366	17	1.121
229	20	5.591	19	6.082	18	6.200	17	6.376
230	20	2.680	19	3.149	18	3.408	17	3.754
231	20	3.231	19	3.210	18	3.036	17	2.805
232	20	4.471	19	4.401	18	4.233	17	3.825
233	20	3.432	19	3.358	18	3.215	17	2.900
234	20	2.302	19	2.297	18	2.168	17	1.991
235	20	1.705	19	1.815	18	1.933	17	1.938
236	20	2.398	19	2.646	18	2.907	17	3.011
238	20	2.798	19	3.287	18	3.566	17	3.905
239	20	2.702	19	3.191	18	3.486	17	3.836
245	20	.433	19	.423	18	.414	17	.407
246	20	1.371	19	1.388	18	1.379	17	1.308
247	20	1.176	19	1.194	18	1.207	17	1.172
248	20	.885	19	.921	18	.924	17	.910
249	20	.563	19	.582	18	.582	17	.572

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16. Abstract

Results from pressure distribution tests on 0.04-scale and 0.02-scale models of the forward fuselage of the Space Shuttle Orbiter are presented without analysis. The tests were completed in the Langley 20-Inch Mach 6 Tunnel. The 0.04-scale model was tested at angles of attack from 0° to 35° and angles of sideslip from 0° to -4°. The 0.02-scale model was tested at angles of attack from -10° to 45° and angles of sideslip from 0° to -4°.

The tests were conducted in support of the development of the Shuttle Entry Air Data System (SEADS). In addition to modeling the 20 SEADS pressure orifices, the wind-tunnel to models were also instrumented with orifices to match Development Flight Instrumentation (DFI) port locations currently existing on the Space Shuttle Orbiter Columbia (OV-102). This DFI simulation had provided a means for comparisons between reentry flight pressure data and wind-tunnel data.

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